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FOUNDRY TRADE JOURNAL

AND PATTERN-MAKER.

Vol. 21. No. 215. NOVEMBER 1919. Price SIXPENCE Net.

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JARRING

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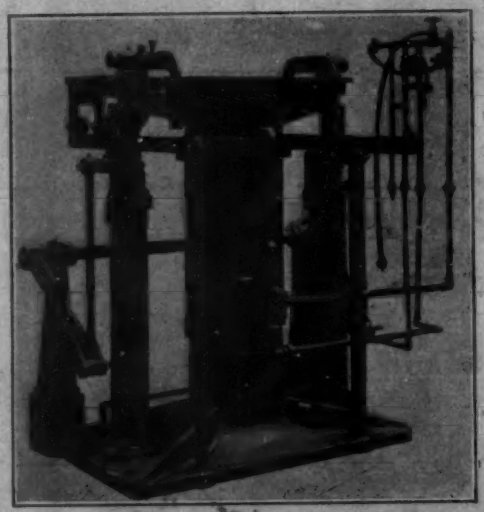
MACHINE.



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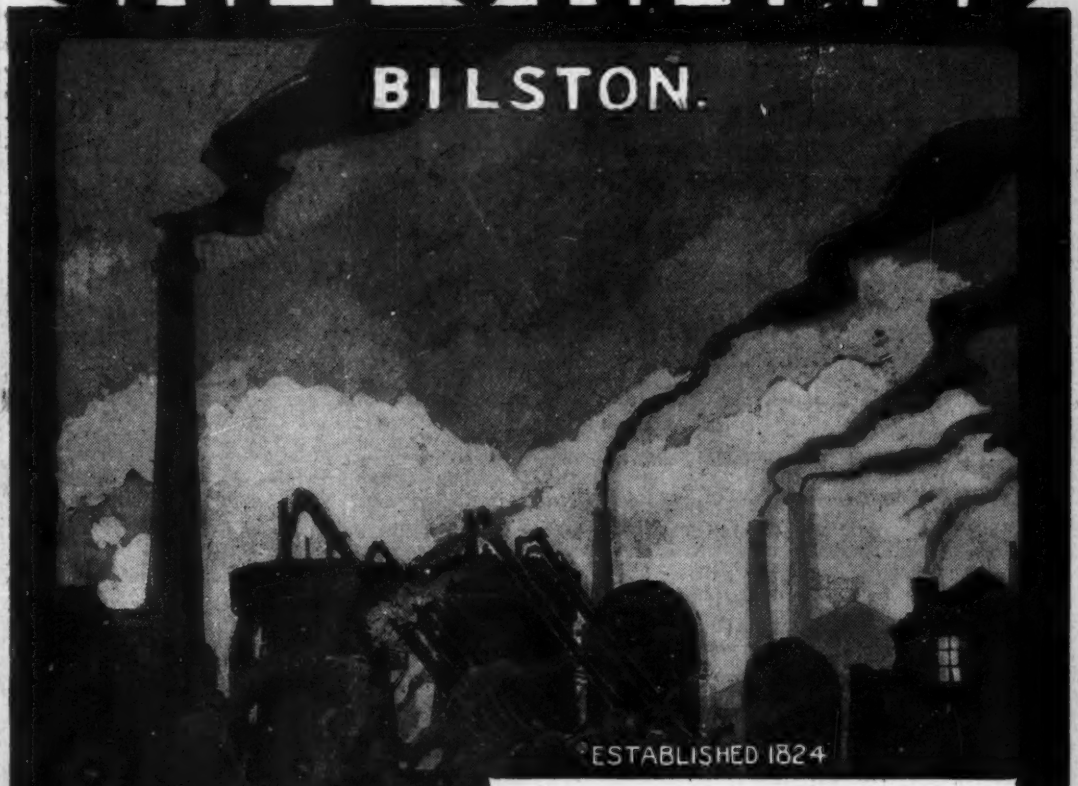

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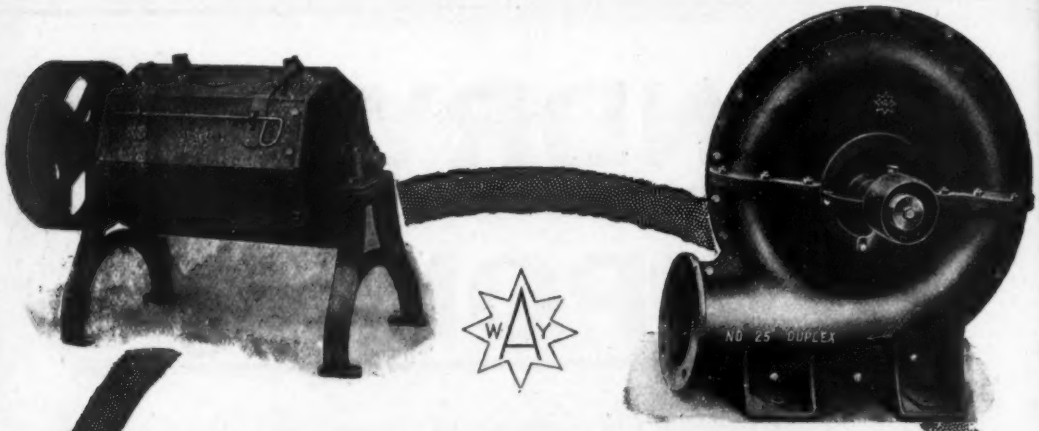

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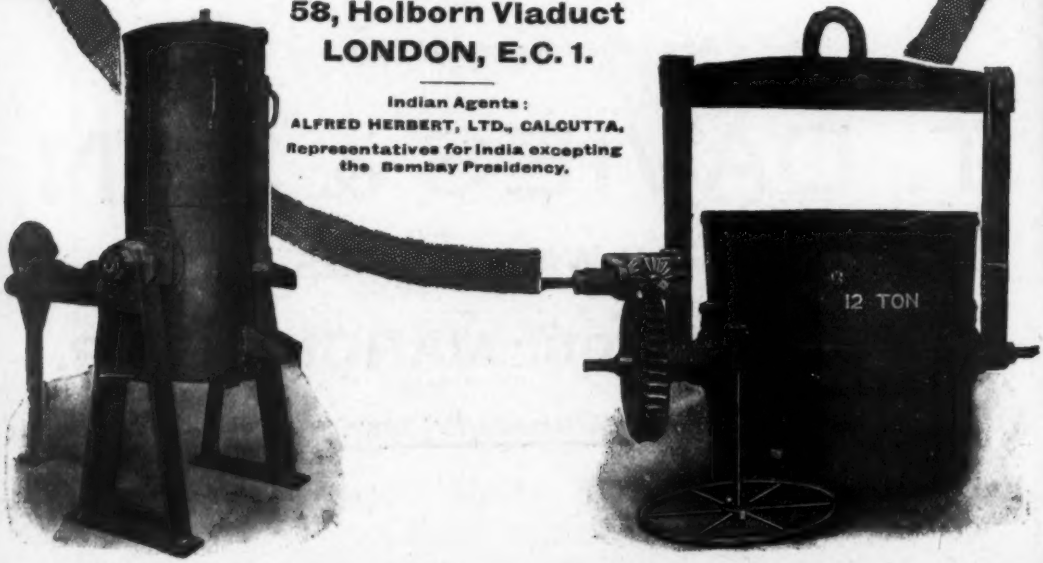

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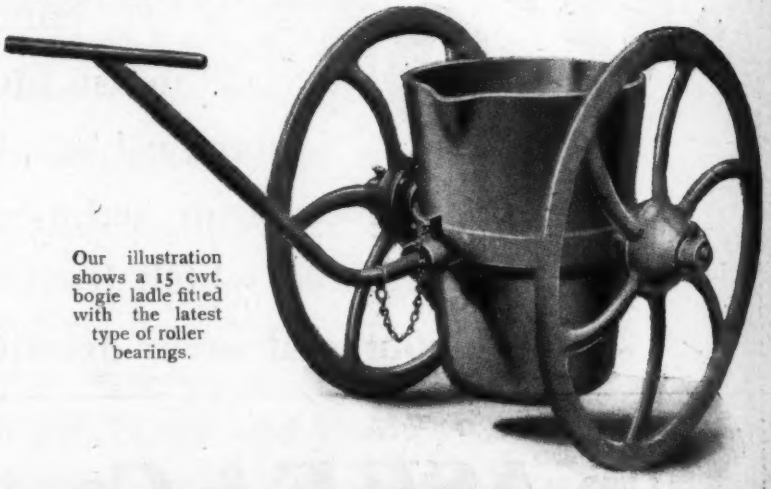

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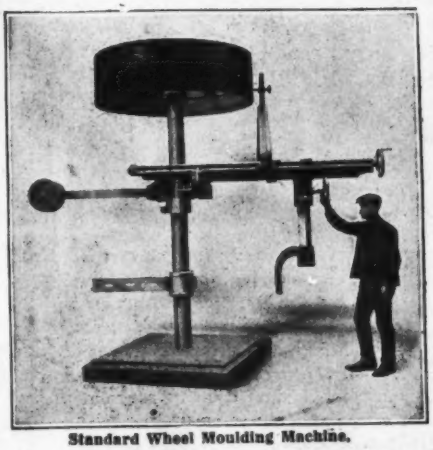

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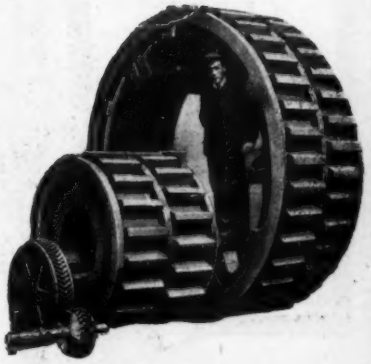

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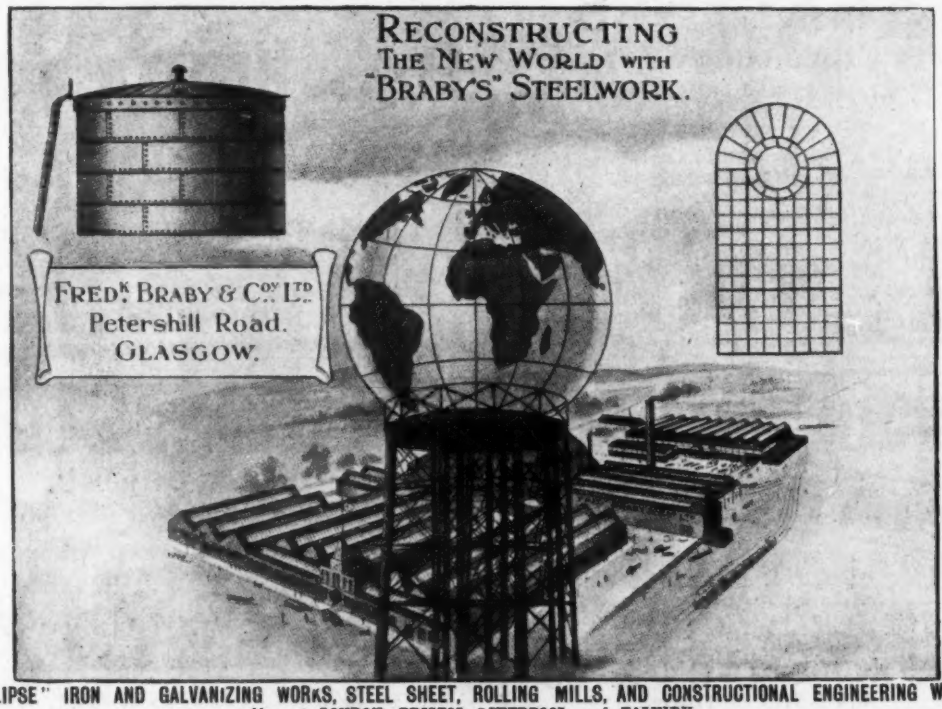

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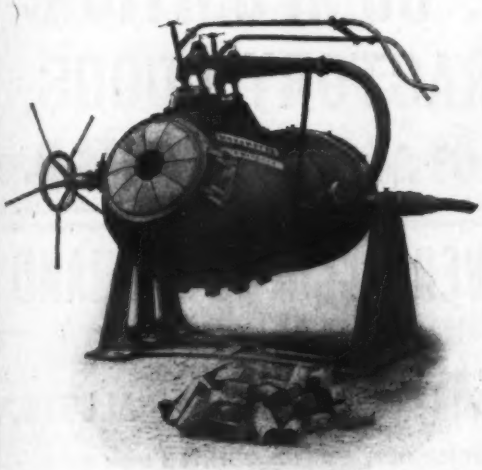

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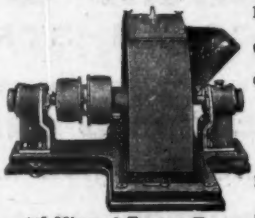

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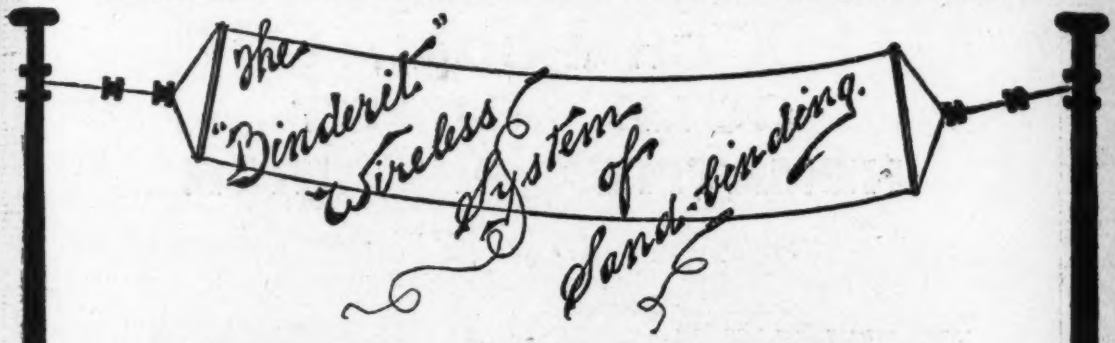

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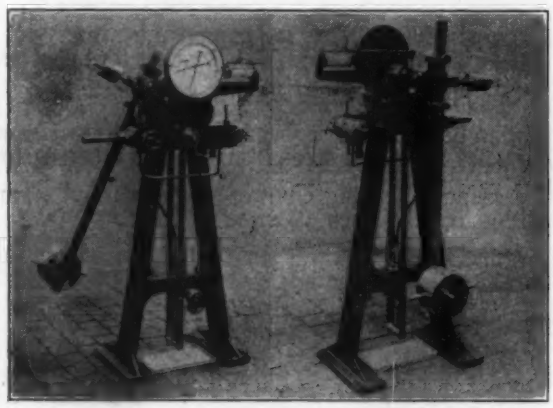

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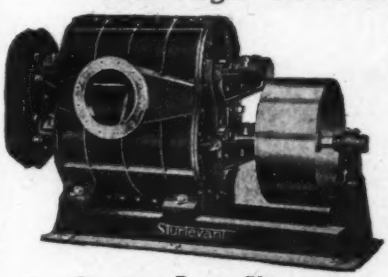

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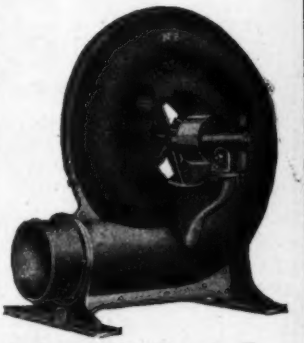

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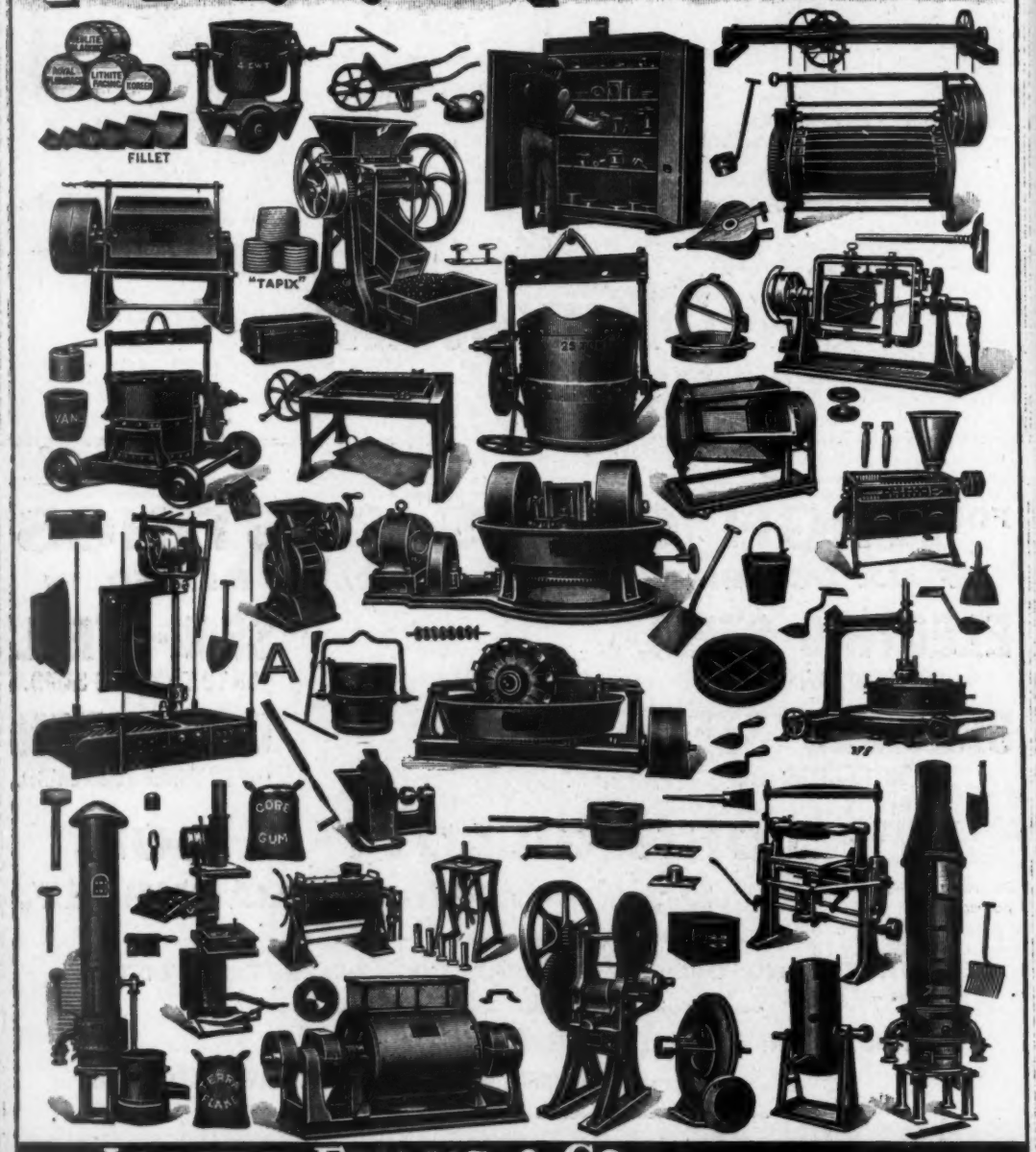

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The Foundry Trade Journal

AND PATTERN MAKER.

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Forthcoming Events.

NOVEMBER 5.

Institution of Automobile Engineers:—"Valve Failures and Valve Steels in Internal Combustion Engines," by Dr. L. Aitchison.

NOVEMBER 14.

West of Scotland Iron and Steel Institute:—"Electric Furnaces," by J. Bibby.

NOTES AND COMMENTS.

Synthetic Cast-Iron.

The problem of the disposal of steel scrap in the form of borings, turnings, and similar forms has always been one of considerable difficulty. During the past war-time period this difficulty was considerably increased as a direct result of the huge quantities of turnings and borings rendered available by the increased shell production programme. The difficulty of the disposal of these very light forms of scrap is not confined to the ferrous materials alone, and the same difficulties in a more enhanced degree are encountered in the disposal of non-ferrous metal-borings, turnings and swarf.

The chief difficulty in dealing with all these finely-divided forms of material is due to the excessive loss and trouble experienced during remelting. This difficulty is largely due to the readiness with which oxidation of the material takes place on heating prior to melting. The large volume occupied by a comparatively small weight of material when in the form of turnings is by no means a consideration to be overlooked when dealing with the problem of its disposal. Another objection which takes a prominent place in the mind of the steel-maker called upon to utilise scrap steel in one or other of these various forms is the uncertainty as to the chemical composition of this material. No special care, as a rule, is taken in sorting and storing borings and other steel swarf of different composition. During the war, as a result of the large increase in the use of special alloy steels, this aspect of the problem became of sufficient magnitude to warrant serious consideration.

In the early days of the war the problem of the disposal of these forms of steel scrap became very acute, and the only outlet available was the blast furnace. In a recent memoir on "The Iron and Steel Industry during the War," Dr. Hatch states that the blast-furnace owners were originally very sceptical regarding the use of this material. In the end, however, they consented to its use, and it proved so satisfactory that at a later date when owing to the shortage of other forms of steel scrap the steel makers were able to absorb a greater percentage, the diversion of this material to the steel works was objected to by blast-furnace owners. We give on another page an account of the use of steel borings as a part of the blast-furnace burden by our Allies in France. A certain amount of difficulty also was encountered originally in persuading the basic steel manufacturers to increase their scrap percentage per melt. This was eventually overcome, and according to the figures given by Dr. Hatch, the raising of the percentage of scrap from 34 per cent. to 47 per cent. of the charge resulted in a saving of 750,000 tons of pig-iron per annum for the same ingot output.

The remelting of steel scrap in the form of turnings, etc., in such a manner as to simultaneously re-carburise them with the ultimate production of a highly carburised alloy, ostensibly a white pig-iron, is not new. The remelting of steel in the ordinary foundry cupola results in the simultaneous recarburisation of the scrap, and this process appears to have been devised in the first place in connection with Bessemer-steel practice. The late Mr. L. F. Gjers,

of The Gjers Mills Company, Middlesbrough, was probably the first to introduce this process as far back as the eighties. Dr. Stead, in discussing the report of the Malleable Cast-Iron Committee of the Iron and Steel Institute in 1917, mentioned the fact that he himself had used this process years ago for the production of highly carburised fluid iron for the purpose of recarburising Bessemer-blown metal. It is interesting to note that Dr. Stead's product was a white iron having the composition : CC 3.00 per cent. Si nil, S 0.15 per cent. Mn 0.4 per cent. It has also been shown by J. E. Hurst ("Engineer," November 27, 1916, and August 2, 1918) that steel borings could be successfully melted by this process for the production of a white pig-iron which, with suitable additions of silicon in the form of ferro-silicon, could be used in the manufacture of malleable castings. The carbon content of the pig-iron obtained in these experiments was round about 3 per cent.

Processes of this nature in which steel borings and turnings are remelted and recarburised in the ordinary foundry cupola have been used to a limited extent chiefly for the two objects above mentioned, and pig-iron produced in this manner is very frequently termed synthetic pig-iron.

The remelting of steel borings in this manner, however, possesses several disadvantages which militate against the more extended adoption of this process. These disadvantages are briefly as follows :—(1) The difficulty of handling large quantities of borings owing to the excessive bulk per unit weight. (2) The danger of "scaffolding" and the tendency to throttling of the blast with the finer grades of swarf. (3) The comparatively high loss due chiefly to oxidation and to the complete removal of the finer material by being blown out of the stack. (4) The difficulty in preventing the absorption of sulphur.

On the face of it, it appears highly probable that these disadvantages could be surmounted by the use of specially designed plant. There still remains, however, the difficulty of preventing the absorption of sulphur. (It is important to bear in mind that these disadvantages do not apply when the process is carried out utilising heavier grades of steel scrap.)

The use of various hearth types of furnaces for remelting and carburising have also been attempted, but have not been extensively carried out.

The electric furnace as a means for remelting steel and iron scrap, particularly in the form of turnings, has now attained a recognised position. The essential feature of this type of melting arrangement is that its internal atmosphere can be controlled within exceedingly narrow limits, and the composition of the molten metal and slag covering varied at will. It is quite natural that this type of furnace should be applied to the production of synthetic pig-iron by melting and simultaneously recarburising the steel borings. Details of the development of this process in France during the war at the Livet and other plants working under the Chas. A. Keller patents were given in a paper before the recent Iron and Steel Institute meeting. (See "Foundry Trades Journal," October, 1919.) In the Keller process the recarburisation of the borings is simultaneously effected by the addition of anthracite. Advantage is also taken of the possibility of slag-control for the addition of a predetermined quantity of silicon, and also for effecting dephosphorisation and desulphurisation. With turnings containing—Si. 0.44 per cent., and Mn. 0.55 per cent. and S. 0.07 per cent., a white iron of the following composition was obtained :—C., 3.55 per cent.; Si. 0.52 per cent.; Mn., 0.46 per cent.; S., traces.

The advantages of the electric furnace in this connection will be readily appreciated; and there is no doubt that from a metallurgical point of view it offers the most efficient methods of remelting material in the form of borings. The most serious and outstanding disadvantage, particularly in this country, is the high working of the cost of the furnace. Both Sir Robert Hadfield and Dr. Stead, in discussing the Keller process, pointed out this disadvantage, and also the futility of converting steel borings by way of pig-iron into steel.

From the foundryman's point of view the process, however, will be of considerable interest in that it was utilised for the production of semi-steel shell for the French Ordnance Department. A remarkably pure material of high-silicon content was produced, the analysis of which was given as follows :—Total C., 2.9 per cent.; Si., 1.75 per cent.; Mn., 0.50 per cent.; S., trace; P., 0.05 per cent. The most important feature of this material is its tensile strength, which is given as 50 kg. per sq. mm. This is practically equivalent to 32 tons per sq. in. (50.40 kg. per sq mm. equal 32 tons per sq. in.). It is very unfortunate that no details of the size of the test bars as cast were given; but in spite of this the strength of this material is extremely high. We venture to suggest that the production of cast iron of this order of strength is in itself sufficient to warrant the more extended adoption of the electric furnace process of the production of synthetic cast-iron.

Books Received.

We have received from Messrs. Jordan & Sons, Limited, 116 and 117, Chancery Lane, W.C.2. a copy of the ninth edition of their handbook dealing with "Private Companies," by Herbert W. Jordan. The book contains in a concise form much valuable information regarding the status of private companies, and the exemptions they enjoy. An extensive index greatly adds to the usefulness of this little volume, which can be obtained from the publishers for 1s. 4d. post free. A further publication is entitled "Reminders for Company Secretaries," 11d. post free, and should prove of great use to those engaged in company secretarial duties.

WAGES IN GERMANY. — The August issue of the Journal of the German Department of Labour Statistics gives the following official estimate of the increase, in money wages of industrial workers in Germany during the war period. The average wage of the adult male worker has risen between March, 1914, and September, 1918, from 5.17 to 12.46 marks and that of women workers from 2.28 to 6.01 marks. Individual trades show greater increases. In the electrical trades, for example, during the period covered, men's wages have risen from 4.52 to 13.46 marks; in the engineering trade from 5.32 to 13.04 marks. Wages of women in the metal industry have risen from 2.05 to 6.65 marks; in the engineering trade from 2.28 to 6.26 marks, and in the electrical industry from 2.75 to 7.35 marks.

INSTITUTION OF BRITISH FOUNDRYMEN.— The London Branch opens its 1919-1920 session on October 16, when Frank E. Pitts, Branch President, delivered his Presidential Address. Subsequent meetings will be held as follows:—*November* 1, visit to the Brimsdown Foundry Company's works. *November* 13, paper by A. R. Bartlett (of Fraser & Chalmers, Erith), "The Core Floor and some Essentials in connection." *December* 18, Open Night. *January* 8, paper by John Holden (of Newcastle Alloys Company), "Electric Steel Melting." *February* 12, paper by H. Sherburn (of the Richmond Gas Stove & Meter Company), "The Production of Pattern Plates for Repetition Casting." *March* 11, paper by Alexander Hayes. "Foundry Organisation—Technical and Commercial." The meetings are held at the Cannon Street Hotel on Thursday evenings, at 8 p.m. Members are invited to send in to the secretary questions on foundry problems or difficulties, to be answered or discussed, and these will be taken up for discussion at the end of each meeting, time permitting.

Institute of Metals.

The annual autumn meeting of the Institute of Metals was held at Sheffield on Wednesday and Thursday, September 24-25, Professor H. C. H. Carpenter occupied the chair.

It was announced that the Council's nominations of officers and council for the year 1920-21 were:—President, Engineer Vice-Admiral Sir George Goodwin, K.C.B. (London); vice-presidents, Mr. L. Summer (Manchester), and Mr. G. A. Boeddicker (Birmingham); members of Council: Messrs. W. H. Allen (Bedford), A. Cleghorn (Glasgow), J. Dewrance (London), S. Evered (Birmingham), and H. B. Weels (Barrow-in-Furness). The above names will be included in the ballot list which will go forward to the members before the March meeting.

Abstracts of some of the Papers are given below:—

OBSERVATIONS ON A TYPICAL BEARING METAL.

By Miss Hilda E. Fry and W. Rosenhain, D.Sc., F.R.S. (the National Physical Laboratory).

Summary.

The observations described in this Paper embody the results of an investigation into the effects of pouring conditions on the microstructure and hardness of a white bearing metal of the composition copper 4.4 per cent., tin 86.8 per cent., antimony 8.8 per cent. The results show that the method of casting such an alloy influences the microstructure to a marked degree, and that by varying the temperature of pouring and the type of mould, great variations in grain-size can be produced. Further, not only does slow cooling result in a coarse structure and rapid cooling in a fine-grained structure, but the relative temperatures of the molten meal and the mould have a pronounced influence on the uniformity of grain from side to side of the casting.

The tables of Brinell numbers for this alloy indicate that though the chill-cast ingots are generally harder than the sand-cast, there are no great differences in hardness to correspond to the difference in casting conditions. A remarkable feature is the fact that hammering of the ingots results in appreciable softening, which is more pronounced if the cold work is followed by a light annealing treatment.

GRAPHITE AND OXIDE INCLUSIONS IN NICKEL SILVER.

By F. C. Thompson, D.Met., B.Sc. (Sheffield).

Summary.

The precipitation of graphite from carbonised nickel silver occurs around the crystals in the case of cupronickel. This graphitisation, which occurs on annealing the metal at temperatures above 700 deg. C., renders the alloy extremely brittle. There is no means of preventing a gradual carbonisation as a result of repeated remeltings of scrap. All that can be done is to dilute continuously the alloy with new metal. Graphitisation occurs first at the surface and hence passes inwards. Nickel silver oxidised during melting shows aggregates of small globules of zinc oxide which are not appreciably deformed as a result of subsequent rolling, a fact which enables such inclusions to be differentiated from slag.

CONSTITUTION AND METALLURGY OF BRITANNIA METAL.

By F. C. Thompson, D.Met., B.Sc., and Captain F. Orme, M.Met. (Sheffield).

Summary.

A few notes on the constitution and metallurgy of Britannia metal have been compiled by the authors. The full analysis of the alloy used, which is typical of good modern material, is:—Tin, 93.38 per cent.; antimony, 4.70 per cent.; copper, 1.0 per cent.; lead, 0.55 per cent.; iron, 0.36 per cent. A description of the melting and casting operations is given.

Samples of the alloy were taken:—(1) Cut from a commercial ingot; (2) after heating to 170 deg. C. and quenching; and (3) after reheating to 200 deg. C. and slowly cooling; and the Brinell hardness determined. The quenched sample was up to a point, distinctly harder than the other two. When, however, the stress passed a certain value (600 kgs.) the material broke down and became actually softer than the untreated samples. The effect of reheating followed by slow cooling is to soften the alloy distinctly. In the rate of cooling, rather than the temperature from which the alloy is cooled, does the cause of the hardening lie.

Thin discs, cast in cast-iron chills, were comparatively hard. According to the scleroscope, their hardness was double that of the ingot (12-6), although the Brinell figures differed comparatively little. In the absence of the thermal-equilibrium diagram it is difficult to discuss the microstructure of Britannia metal. The authors, however, suggest that the constitution of the alloy is one of the Sn-Sb delta solution embedded in the Cu-Sn eutectic as ground-mass. Both these constituents freeze at about the same temperature, the cooling curve showing but one large and rather expanded evolution of heat at 235 deg. C. After quenching, and after chill-casting, there is a marked diminution in the amount of the white constituent present.

PROPERTIES OF STANDARD SILVER, WITH NOTES ON ITS MANUFACTURE.

By E. A. Smith, A.R.S.M., and H. Turner (Sheffield).

Summary.

Standard, or sterling silver, containing 92.5 per cent. of silver, the only silver alloy of industrial importance, has been the legal standard alloy for all British silver coinage, and so-called silver plate from early times. Apart from special investigations undertaken for mint purposes, little has been published hitherto on the properties of standard silver in relation to its employment for industrial purposes, and the purpose of the present Paper is to record a number of tests made on the metal, and to draw attention to important details to be observed in its manufacture.

When the alloy is cast there is a tendency for the silver to become concentrated in the middle of the ingot, but when proper precautions are taken the differences in composition in different parts of the ingot are not sufficient to interfere seriously with the application of the alloy to minting and to industrial purposes. The authors have found the temperature of the metal in the crucible when ready for casting to be about 1,200 deg. C., and the temperature of the stream during pouring to be about 1,113 deg. The best temperature for annealing in works practice has been found to be 670 deg. for all-round work. The time necessarily varies according to the thickness of the sheet, but generally, annealing is complete in from 20 to 30 min. The hardness of the metal at successive stages of cold rolling has been determined, and the results plotted as a graph. The maximum Brinell hardness of standard silver is about 183. The maximum tentile strength varied from 11 to 14 tons per sq. in., according to the method of casting. Results are given for the Charpy impact test, and the Sankey alternating-bend test.

MOULDING SANDS FOR NON-FERROUS FOUNDRY WORK.

By Prof. P. G. H. Boswell (Liverpool).

Summary.

Although the difficulties arising from the use of unsuitable moulding sands in the casting of non-ferrous metals are not so acute as in the case of steel, the former carries with it problems peculiarly its own

The investigation of moulding sands in works' laboratories is urged, and the methods of testing and standardising such sands are indicated. The use and significance of chemical, mechanical, and mineral analyses are emphasised, and it is found that in sands used for non-ferrous work, the mechanical analysis (or texture) rises to the position of prime importance. Methods of graphical representation of the results of analyses are illustrated.

The bond of moulding sands may be natural or artificial, or both. The natural bond is either hydrated iron oxide or clay, and in order that the bonding power should be a maximum the clay or other material should be evenly distributed round the quartz grains. Hence the importance of the proper mixing and milling of moulding sands.

The location of British sources of suitable sands in relation to the areas engaged in non-ferrous foundry-work is then discussed. The nearest and most suitable supplies to each metallurgical district are indicated, the distribution being shown upon a map. Not only are home resources of such sands abundant, but they are exported to many parts of the world.

SECOND REPORT TO THE BEILBY PRIZE COMMITTEE ON THE SOLIDIFICATION OF METALS FROM THE LIQUID STATE.

By Prof. Cecil H. Desch, D.Sc., Ph.D. (Glasgow).

Summary.

The present interim Report deals with two questions which have arisen in the course of the main investigation, namely, the form of crystal grains and the conditions of cellular convection. If the form of crystal grains were determined by surface tension, as is required by Quincke's hypothesis, they would resemble very closely the cells in a mass of foam. It is shown that foam-cells, whilst variable in shape, tend to resemble the pentagonal dodecahedron. Grains of beta-brass, isolated by mercury, are found to be similar to foam-cells. The polygonal boundaries of crystal grains in plane sections have also been examined, and compared with the theoretical sections of the polyhedra which would be produced by growth from centres under certain assumed conditions. A comparison of the diagrams obtained leads to the conclusion that surface tension has an important share in determining the form of the grain boundaries, although it does not follow that Quincke's assumption of the preliminary separation into two liquids holds good. Two forces, that of surface tension and the directive force of crystalline cohesion, are opposed to one another, and their resultant determines the boundary.

The second part describes experiments to determine the difference of temperature between the centre and periphery of a convection cell in a liquid cooling under the conditions of Bénard's experiments. Differential thermo-couples of fine wire have been used, and the results show that the difference of temprature may amount to 6 deg. C., or even more in cells of molten wax 18 mm. in diameter and about 1.5 deg. in cells of soap solution 300 mm. in diameter. Such differences are quite sufficient to account for the preferential freezing at the borders of cells, which is sometimes observed.

EARLY HISTORY OF ELECTRO-SILVER PLATING.

By R. E. Leader, B.A. (Sheffield).

Summary.

The real history of electro-plating begins with the time when John Wright, a young Birmingham surgeon, found in cyanide of potassium the medium by which the electro-chemical deposition of the precious metals became a manufacturing possibility. The date was September, 1840, when Wright's process, embodied by agreement in a patent taken out by George Richard Elkington and Henry Elkington, became the basis of all future electro-silver plating. But before that basis had been unassailably fixed a long period elapsed. The manufacturers of old Sheffield plate treated the new process with contempt, and retailers were mostly hostile. Beyond details of manipulation and output, the validity of the patent was challenged from many quarters, and protection was sought for a multiplicity of rival methods. The Elkington resisted all these attempts, and, while upholding their own priority, strengthened their monopoly by acquiring control over all real improvements, whether by way of new solutions or by devices for the more efficient application of electrical energy. While enthusiastically devoted to the development of the artistic possibilities of electro-plating, one of the most outstanding successes of the Elkington firm in popularising their new method was the acquisition from Krupp, of Essen, of machinery for producing, in unlimited numbers, cheap yet durable spoons and forks. In something like ten years the manufacture of old Sheffield plate had been killed, and electro-plating had furnished the households of the large middle-class population with goods ranking between the solid sterling silver of the rich and the Britannia metal of the poor. The Paper strictly confines itself to the early history.

THE TERNARY ALLOYS OF TIN-ANTIMONY-ARSENIC.

By J. E. Stead, D.Sc., D.Met., F.R.S. (Middlesbrough), with Notes by Mr. J. Spencer, M.A., F.G.S. (Natural History Museum).

Summary.

The Paper contains a short review of a Paper read before the Society of Chemical Industry, in 1897, on the ternary alloys of tin-antimony and tin-arsenic, in which it was shown that cold alloys containing between 92.5 and 75 per cent. tin and 75 and 25 per cent. antimony contain cuboidal crystals having the composition of Sb-Sn embedded in a eutectic consisting of a solid solution of 92.5 per cent. tin and 7.5 per cent. antimony; also that cold alloys containing arsenic from traces up to 5 per cent. and 99.95 per cent. and 95 per cent. tin contain crystals in the form of flat plates, which, on being separated, were found to have approximately the composition of Sn_4As_3, and a matrix of practically pure tin. The separated crystals have been recently examined by Mr. J. L. Spencer, who describes them as rhombohedrons (trigonal).

The interesting feature of the Paper is the character of the ternary crystals that form when some of the alloys containing tin, antimony and arsenic solidify. In the slowly cooling alloy containing 70 per cent. tin, 25 per cent. antimony, and 5 per cent. arsenic, more or less complete spherical shells grow, leaving as the matrix the eutectic of the ternary alloy of tin plus antimony containing only traces of arsenic. If the alloys contain less than 2.5 per cent. arsenic when associated with 25 per cent. of antimony and the balance of tin, the crystals formed are cuboidal and not spherical, but when the arsenic exceeds 2.5 per cent., the antimony remaining at 25 per cent., the crystals begin to change from the cubic to the spherical form. It is not till the crystals themselves contain a ratio of arsenic to antimony of more than 1 to 7 that the spherical forms become pronounced, but no arsenic remains in any alloy in the eutectic for all of it crystallises out in the ternary crystals whether they are cuboidal or spherical. When the arsenic is maintained at 5 per cent. and the antimony varied, it is not till the antimony exceeds about 8 per cent. that the perfectly flat crystals begin to change into segments of spheres. In these alloys the whole of the arsenic is included in the separate crystals, and none remains in the eutectic.

In an appendix to the Paper presented at the meeting the author gave analyses of the fragments of the cleavages from the central portions of the spherical crystal shells, and yielded on analyses 60.15 per cent. tin, 27.5 per cent. antimony and 12.45 per cent.

arsenic. The analysis of the whole crystals approximated to 48 per cent. tin, 42 per cent. antimony, and 10 per cent. arsenic.

The Paper was fully illustrated, and some of the illustrations were printed direct from the deeply etched alloys.

SEASON CRACKING.

By Dr. W. H. Hatfield (Brown-Firth Research Laboratories, Sheffield), and Captain G. L. Thirkell, A.E., A.I.F., B.Sc. (Tasmania).

An extremely interesting specimen of season or age cracking in a brass flower-bowl, came to the author's notice some time ago. To their certain knowledge it was perfect twelve years ago, and, indeed, for some years afterwards, but at a later date it progressively developed numerous cracks. The bowl had evidently been drawn out, spun, and probably finally malleted from a disc of rolled sheet brass, and appeared to be lacquered on the external surface. It had certainly not been called upon to resist applied stresses during its lifetime, and any stresses which could have caused the cracks must have been inherent in the article when it was first put into service.

An analysis was made of the brass, which disclosed no nickel, antimony, aluminium or manganese, and only traces of arsenic and sulphur. The other constituents showed the following percentages:—Copper, 63.93; zinc, 35.92; lead, 0.363; tin, 0.033; iron, 0.113; bismuth and cadmium, less than 0.005 each. The earliest micro-examination consisted of an examination of the external surfaces of the bowl in the vicinity of one of the cracks which were here and there accompanied by definite corrosion from the surface inwards. A superficial examination of the bowl had also revealed substantial corrosion in many areas.

The microstructure of the bowl was examined sectionally and on the surface, and interesting photographs were obtained, which accompany the Paper.

Brinell hardness determinations with a small ball showed that the hardness varied from 128 in the upper portion where the material had been severely worked, down to 62 in the base where the material had not been worked at all, or, at any rate, had been worked very little. By comparisons with the work of other investigators in similar metal, the comparative amount of work which the metal had received could be surmised. Tensile tests were made upon material cut from the walls of the bowl. Strips ¼ in. wide with 1 in. parallel were used, and two tests taken circumferentially gave M.S. 23.6 and 23.3 tons per sq. in. A third piece taken vertically gave 22.1 tons per sq. in.

Subsequent test-pieces were cut from the sides of the bowl and annealed at different temperatures. In their original state they would not bend more than 90 deg. before cracking, but after annealing at 450 deg. C. for four hours were much softer and less brittle. Microscopic examination showed that the metal had partly recrystallised. Specimens annealed at 550 deg. C. for one hour became quite soft and ductile, and apparently had, by that treatment, lost all their previous brittleness. The metal had quite recrystallised.

It was thought that the most obvious way to find a solution of the tendency to crack lay in actual direct experiments in spinning. Over a considerable time cups were spun in brass and in nickel-silver. Rings were cut at regular intervals down the cup, and after being carefully measured were severed, and the change of diameter over the original dimensions provided data for calculating the stresses inherent in the metal as a result of the cold work. After much evidence had been obtained in this manner a systematic attempt was made with brass similar in composition to that in the brass flower-bowl under investigation.

Seven cups were made from the same sheet of brass of gauge 12 in. thickness. The same amount and quality of work was put on to each cup under practically identical conditions. As regards size, the cups were 2.33 in. high, by 2.33 in. diameter at the top. They were all measured up, and Cup A was placed in $HgNO_3$, in which it split after seven minutes' immersion. Cup B was cut into rings and the stresses were calculated according to a method explained in the Paper. Cup B1 was annealed for four hours at 100 deg. V., cut into rings, and the stresses calculated. Cup C was annealed for four hours at 250 deg. C., measured, cut into rings, and the stresses calculated. Cup D was annealed for four hours at 450 deg. C., cut into rings, and the stresses calculated. Cup E was annealed for four hours at 600 deg. C., cut into rings, and the stresses measured. Cup F, after annealing for four hours at 450 deg. C., was put into $HgNO_3$ for twenty-four hours and did not crack.

The stresses in the different cups as affected by the different treatments are given by the authors in a table and plotted in a diagram.

During the spinning experiments it was found that when the material was overworked without annealing, as would be expected, cracks were produced. The experiments showed also that cracks induced by mercurous nitrate were mainly between the crystals. The work which the authors have in hand is not yet completed, but it was thought that sufficient evidence had been secured to present to the Institute.

Malleting after spinning, whether practised in brass or in nickel-silver, resulted in an apparent lowering of such stresses produced in spinning, comparative values of the amount of "spring" of comparative examples being in the ratio of 16:10 in favour of the subsequent malleting, although local high stresses may result. Incidentally the curves produced by plotting the stress in tons per sq. in. against the position in the cup in inches clearly brought out the effect of critical amounts of work on lines similar to those indicated in several recent papers. The work in this direction, however, must be deferred to a later communication.

The flower-bowl which formed the subject of the investigation was probably pressed and spun from a disc or rolled sheet, and was most likely annealed at successive stages of cold work, and then no doubt finally hammered to give the pattern. As pointed out during the account of the investigation, it was left in a quite hard, cold-worked condition. Their inquiries lead the authors to the conclusion that the brass in the upper portion of the bowl was internally stressed to such a degree that it only needed minor corrosion effects to lead to the local concentration of stress to provide stresses within the material which it could not reasonably be expected to withstand. Hence the production of the cracks. Intrinsically the brass from which the article was made was not of an unsatisfactory composition, and, if, instead, of being left in the hard, cold-worked condition, the bowl had been suitably annealed, cracking would not have taken place.

Spun brass articles may contain internal stresses approximating to the maximum stress of the material. This stress in tons per sq. in. tensile of the original brass bowl was in the neighbourhood of 22-25 tons per sq. in. in the hardest portions, and in the experimental spun cups stresses were attained approximating to 20 tons per sq. in., but the objectionable internal stresses could be removed altogether by annealing.

Theories previously advanced in explanation of the phenomenon of season cracking were discussed in the Paper, and it was argued, in the light of the experimental work described, that it was not reasonable to look for an explanation for failure in the postulated properties of an amorphous film existing between the crystals.

BAILY ELECTRIC FURNACE.

In connection with the meeting of the Institute of Metals at Sheffield, two exhibitons of slides and of some 2,000 ft. of cinematograph film were given in the University by Mr. Verdon O. Cutts, consulting electro-metallurgist, of that city. They showed the Baily electric furnaces in operation, melting brass, copper,

aluminium, and other non-ferrous metals, and also annealing, heating, and heat-treating steel, brass, and other metals. The furnaces illustrated are at actual work in the United States and Canada, and we understand that arrangements have now been made for their manufacture and installation in this country.

The Baily melting furnaces are made in a large number of standard sizes, of the pit, tilting, and tapping types. One particular size of round tilting furnace, of which there are over fifty in commercial operation, has a normal electrical rating of 105 kw. Its normal hearth capacity is 1,500 lbs., with a melting rate of 600 lbs. per hour, but the unit is flexible and in some instances, under favourable conditions, it has been operated with charges varying from 500 lbs. to 2 tons, and its melting rate has been increased to 1,000 lbs. per hour.

The heating element consists practically of a trough of granular carbon which acts as a "glower," and it is the resistance of this material to the passage of the electric current which generates the heat. The heat is transmitted to the charge by radiation. The natural consequence of this is that it makes an ideal electrical load for the central station. It is stated to have a power factor of 97 per cent., and its load factor, we are told, closely approximates the same figure. It is a heavily heat-insulated furnace, and consequently its size is large compared with its output, which disadvantage, however, is amply compensated by the fact that it is this feature which enables the furnace to be used for melting metals which readily oxidise or volatilise, and their alloys. Instances quoted by Mr. Cutts include a six days' run on yellow brass, in which the metal losses worked out at 1.3 per cent., and another run, over a period of six weeks, in which case the total metal losses worked out at 0.8 per cent. This not only ensures a saving of metal, but also results in exceedingly favourable working conditions and the almost total elimination of occupational disease, due to zinc fumes.

The range of standard sizes in which these furnaces are made is such as to provide for the requirements of both small and large foundries, the rolling mill, and also of comparatively small works dealing with small quantities of a number of varying alloys for which the electric furnace is suitable.

There are no electrodes in the usual sense of the term in the Baily furnaces. Carbon pieces serve to make the permanent electrical connection to the resistance trough. The electrodes, however, are completely embedded and not exposed to the atmosphere. There is, therefore, no appreciable erosion or electrode consumption. The only parts requiring repairs and renewals are the refractories and the resistor material. The latter has to be replenished every fortnight or so when in continuous operation, and facilities are provided for doing this. Owing to the general type and design of the furnace, and the absence of any intense local heat, the refractories are stated to have a long life and to require comparatively little attention.

Among the furnaces there is one of the rectangular tapping type, which is used for remelting aluminium ingots, for which purpose it is rated at 500 kw., and has a hearth capacity of 3 tons. The same type of furnace when used on brass is supplied with 600 kw., has a melting rate of 2 tons per hour, and a hearth capacity of 9 tons. The largest melting furnace of this type which has been built is a 1,000-kw. rectangular tapping furnace with motor-operated doors, and is used for melting zinc cathode. It has a capacity of 200 tons of zinc per day. The average current consumption is 74 kw.-hours per ton, and the metal dross amounts to 2.43 per cent.

Mr. Cutts' films show several installations of heat-treatment furnaces for steel in actual operation. Some are of the pusher-type continuous furnaces for heat-treating steel. Others are of the car type, for annealing steel, copper, brass, and aluminium, while yet others, the most interesting of all, are of the automatic-control type for the heat-treatment of steel castings and forgings in large quantities. The heating element of these furnaces, like that of the melting type, consists of one or more resistance troughs. The furnace temperature and atmosphere are under perfect control, and bright-finish machined aeroplane parts are treated without scaling. The films show two furnaces built close together with a quenching tank between them. The only manual labour required is to place the forgings on the charging platform of the first furnace. All subsequent operations are performed automatically through the medium of electrically-operated hydraulic valves. Thus there are a pair of furnaces 20 ft. long by 7 ft. wide, heat-treating aeroplane motor crank shafts at the rate of 72 tons per day. Between the two furnaces and over the quenching tank is a hydraulic manipulator. The furnaces are automatically controlled by contact-making pyrometers. Thermo-couples situated at the discharge end of the first furnace operate the automatic gear through relays, and we see, first of all, both doors of the first furnace open. A motor-driven pusher charges cold forgings into one end of the furnace, and simultaneously the forgings emerging at the discharge end are transferred to the manipulator. Both doors then close, and at the same time the manipulator conveys the heated pieces down into the quenching tank. A relay governs the time of quenching, at the end of which the manipulator brings up its load and places it on the charging platform of the second furnace. In doing so it makes a contact which starts the motor which lifts the doors, and a pusher charges the forgings into the second furnace, thereby ejecting the completely heat-treated forgings from the discharge end. The furnace doors are automatically closed, and a new cycle of operations begins. In this way every forging receives identically the same heat-treatment.

Birmingham Metallurgical Society.

In the course of his inaugural address before the Birmingham Metallurgical Society, on the 2nd inst., the new President, Mr. F. C. A. H. Lantsberry, M.A., commented upon the great progress made in metallurgy during the war, the extent of which was only now being fully realised through the removal of restrictions on free publication in the technical Press. The bulk of our large manufacturers had appreciated the value of scientific assistance to the extent of providing their works with well-equipped laboratories, but the efforts of those laboratories were hampered, in some cases seriously, by lack of appreciation of science on the part of the men with whom they had to deal. That the Government recognised its responsibilities in this direction was shown by the fact of its having set aside £1,000,000 for the development of research and the establishment of the Department of Scientific Industrial Research, one of the most progressive steps ever taken by a British Government. But the onus of taking the initiative had been rightly placed on the shoulders of manufacturers. The scientific investigator who set out to solve an industrial problem was confronted immediately by the difficulty of being unable to bring to a focus the whole of the existing knowledge of the particular subject, a very serious matter when speed was an essential in the solution of such problems, and Societies, like theirs, might do very good work in assisting in collecting information. They should commence by taking up the study of some particular branch in the same way as the Institute of Metals had taken up the subject of Corrosion, the Institution of Mechanical Engineers the subject of Hardness, and the Manchester Association of Engineers the subject of Tool Steels.

In concluding his address, the President announced that funds for a new prize or medal had been provided by an old friend of the Society, who, in commemoration of the work done by Professor Turner, wished it to be known as the Turner Medal or Prize.

Making Column Patterns.

By Joseph Horner.

Column patterns are characterised by much diversity of forms which considerably affect the details of the pattern work and moulding. The basis, or the shaft, of all columns, except those of very small diameters, is the same, and is made as a lagged-up pattern, *i.e.*, one built with long, narrow strips attached to cross-bars. This is the only way in which a pattern, say, beyond 3 in. or 4 in. in diameter can be constructed to

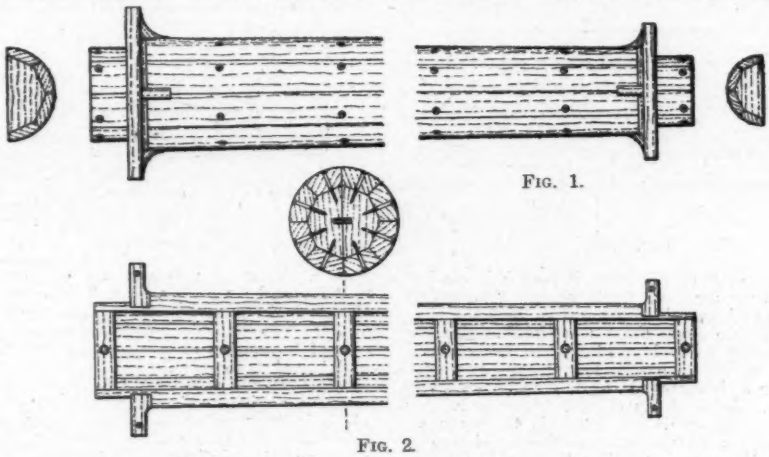


FIG. 1.

FIG. 2.

permanently retain its shape under the conditions of incessant moulding in damp sand.

Figs. 1 and 2 represent the typical plain column pattern in its external appearance, and open in the joint face, respectively. From these figures, with the end views of the core prints, and the section through the shaft, it will be seen that lagging-strips which extend the entire length are screwed (and glued) on cross bars, having flat faces planed to receive the lags. The cross-bars are jointed and dowelled along the centre. The flanges are let into shallow grooves, both to prevent them from getting shifted out of position and to permit of turning the radius on them. Brackets are shown fitted to support the flanges. Eight lagging strips make up the circle, but this number is regulated by the diameter. A 6 in. or an

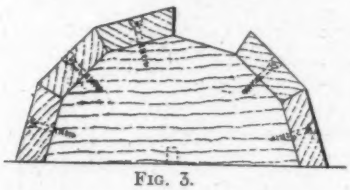


FIG. 3.

8 in. column need not have more than six strips, but a 12 in. column might have ten or twelve, and larger sizes more in proportion. The width of the strips must not be excessive for two reasons; one being that wide stuff will shrink and open along the joints, the other, that the thickness at the joint edges will be lessened with increase of width. The section shows suitable proportions.

The distances between the cross-bars must be such as to afford due support to the lags. If they are much farther apart than the proportions indicated in Fig. 2, the strips will be liable to bend under the ramming, and the joints may start, resulting in lapping. The rigidity of the pattern also depends much on the holding of the longitudinal glued joints. The cross bars are shown with flats to receive the lags, which makes the strips thinner along the jointing edges than elsewhere. To avoid this, circular cross-bars have been used, which entails planing the lagging strips concave to fit them. This is quite unnecessary, entailing much extra labour, with no corresponding advantage.

In the column shown, the thickness of metal is moderate, and there is no moulding, or bell-mouthing. Here, therefore, the lags are continued to the ends of the core prints, which entails a considerable reduction in the thickness over the prints, as seen in Fig. 2.

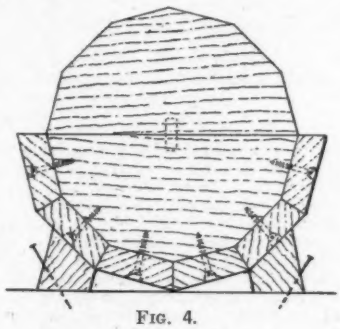


FIG. 4.

But sufficient wood is still left. If the reduction were greater, the end cross-bars would be continued from the terminations of the prints to a little way past the flanges. Or, the prints might be prepared separately and screwed on the flanges.

The sequence of operations in building-up a lagged pattern is shown by Figs. 3 and 4. After the cross-bars have been dowelled, and their facets marked off, and planed, with the slight bevel required, if the column is a tapered one; or square if it is parallel, the halves in which the dowell holes occur are laid

upon a bench, or on a joint board, set by a centre line, and loosely tacked down in their correct relative positions. A straight-edge is, as a precautionary measure, tried along all the faces in order to be sure that the lags will make close contact all down the faces. If incorrect, the high parts must be eased. Then the first lags are glued and screwed next the joint face, the edges being planed alike with a level, set to the exact angle, and quite straight longitudinally, as tested with a straight-edge. Afterwards, the lagging is continued on each side, as shown in Fig. 3, leaving only the final lag to be inserted. Since the joints are long, and so much depends on them, care must be taken both in getting continuous contact and

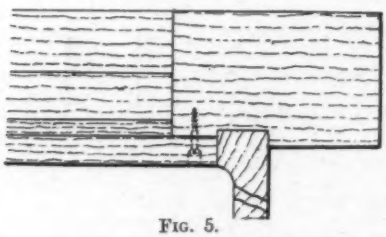


FIG. 5.

in gluing. The exposed joint-face last made is chalked, and the mating face being planed straight, and to the correct level, is rubbed against it until the chalk shows transference along the whole length. The glue is applied rapidly to avoid chilling, and the excess is rubbed out by a to-and-fro longitudinal movement continued for a few seconds by a man at each end. Glue is also applied to the facets of the cross-bars. Iron dogs are then driven in at intervals to retain the joint in contact while the screws are inserted through the lags into the cross-bars. The heads of the screws are sunk into centre-bit holes, as indicated, to prevent

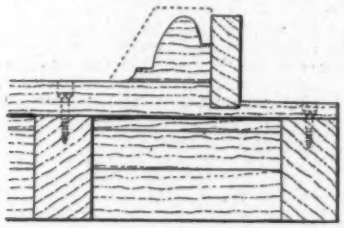


FIG. 7.

their coming into contact with the turning tools. The holes above the heads are filled with wooden plugs. When the last lag is being fitted (Fig. 3) the two joint edges require attention. The half-pattern is then turned over, as shown in Fig. 4. It is supported on blocking pieces, while the other halves of the cross-bars are dowelled in position, and the remaining portion of the pattern is lagged in the same detail as that of the first half. Centre plates are then screwed to the ends, and the pattern is put into the lathe and turned.

We may now note some of the typical variations that are made in column patterns.

The first example is that the fitting of a block for a print as indicated in Fig. 5, instead of extending the lagging to include the print, as in Figs. 1 and 2. In Fig. 5 this is only a matter of individual choice, because the difference in the diameters of the print and of the body is not very great. There is, however, enough difference to make the lagging thinner than is desirable over the print section, and a block like that shown is preferable. But it must be fitted with the grain running longitudinally, as indicated by the timber shading, and not transversely. In the construction shown in Fig. 5 any shrinkage that might occur would be uniform and the circular shape would be preserved; but if a chunky block were fitted with the grain running transversely, shrinkage would produce an elliptical section. The flange is shown in the figure as sunk into an annular recess turned in the print block.

A moulding is shown in Fig. 6 fitted to the pattern,

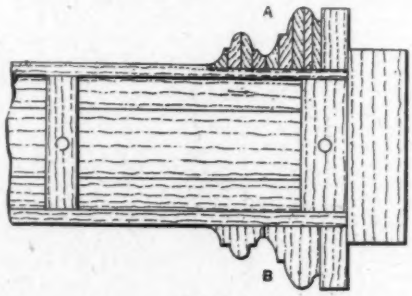


FIG. 6.

with a choice of two methods of construction. At A it is glued up with courses of segments, say, six to the circle in plan. At B it is cut from the solid in two thicknesses. The method at A secures permanence of form, that at B does not, since the wood will shrink and become elliptical, and will also be liable to fracture across the short grain in the vicinity of the pattern joint. The segmental structure therefore at A is to be preferred for standard patterns, but that at B might be adopted for a pattern from which a few moulds only have to be taken.

These mouldings may be turned when attached to the main body, or separate therefrom. In either case the holes to fit over the pattern body must be bored on a face-plate in the lathe, and the mouldings may just as well be turned and finished at the same chucking. A is shown as being let into a shallow recess turned

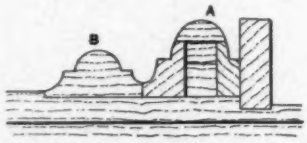


FIG. 8.

on the pattern body in order to afford a little timber to support the radius where the moulding merges into the shaft. B, not being let in, has a feather edge, with short grain near the jointing faces

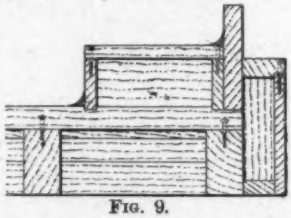


FIG. 9.

The flange, round or square, is prepared separately, and bored to fit over the body. It need not be let into a recess, as in Fig. 5, because it is supported by its contact with the moulding. Here, too, owing to the bell-mouthing of the core to follow the enlarge-

ment of the moulding, the print must be prepared separately, and attached with an abutting joint to the end of the column.

Fig. 7 shows a simple moulding fitted in solid wood, with the grain running longitudinally. This is glued on the shaft in the form of short lags, being an extension of the main lagging strips, and glued on them on flats, or holiowed to fit the curve of the shaft when turned. Should shrinkage take place, it would be equal all round; but the joints may open slightly on the outer diameter. If they do, thin strips can be glued in later, and no further shrinkage will be likely to occur. The flange and the print are made and fitted similarly to Fig. 2.

In Fig. 8 yet another method of making a moulding is shown. The portion at A, standing out to a considerable distance, is built up with segmental pieces in the manner indicated by the timber shading. Two sets of segments have the grain disposed circularly, with a space between, and this is bridged and covered with segments that have the grain running longitudinally. The moulding at B, being shallower, is made by an extension of the lagging, similar to Fig. 7. Both mouldings are prepared as separate sections, turned, and bored to fit a shallow recess turned on the shaft. The flange and print are made as in Fig. 7.

Frequently, instead of a moulding, a large square base terminates the shaft of a column. To attach this as a separate fitting to the end of a round shaft does not make quite so good a job as to fit it in the manner shown in Fig. 9. Here the shaft is continued the whole length, and being recessed, as shown, it is removed from the lathe and the square base is fitted to it by boxing-up. The print also being correspondingly large, is boxed-up, and screwed to the flange. The timber shading illustrates the disposition of the grain in the various portions.

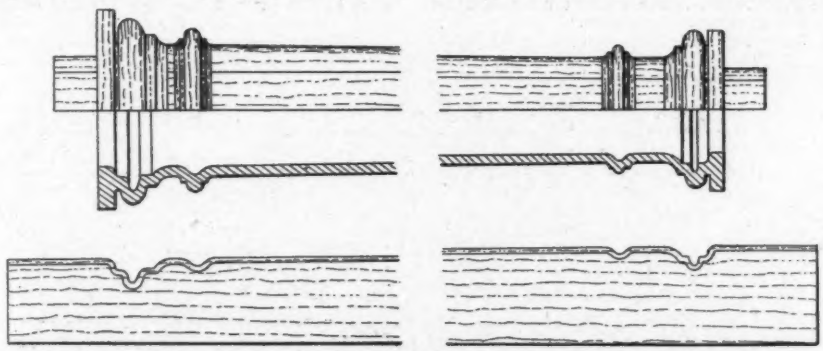


FIG. 10.

When a column has a plain shaft like Figs. 1 and 2, a special core board is not necessary. The prints

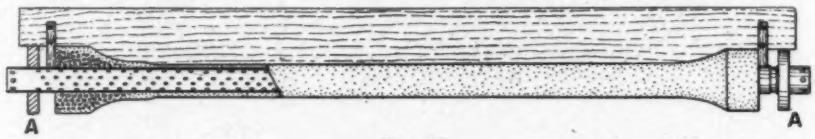


FIG. 11.

give the moulder the diameters at the ends, and the edge of a straight board is used for sweeping. When mouldings are included, the thickness of metal is maintained equally by making the core follow the contour of the mouldings, as in Fig 10. Here the relation of the edge of the board to the core is shown. It is always desirable to preserve very approximately equal thicknesses of metal throughout, since if chunks are permitted to be left in any localities the cooling will be delayed there, and drawing and weakening of the casting will result.

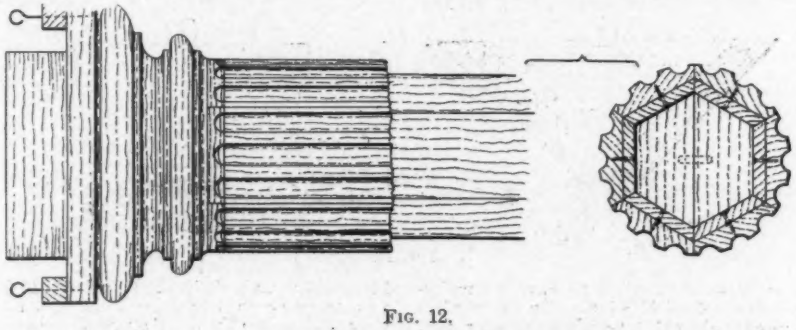


FIG. 12.

In Fig 10 the radius of the sweeping board is set by measurement from the core bar. Inaccuracies of from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. by diameter may easily creep in, with varying metal thicknesses in the castings. Fig. 11

shows a scheme by which this risk can be prevented, when quantities are required. Discs A, A, of wood or metal, are fitted over the bar near the ends, and the print edges of the board are brought up against these. All cores swept will then be of the same diameter.

The foregoing examples have been those of columns with plain shafts. We now consider other patterns of a more or less ornamental character.

Fig. 12 shows how a fluted column must be jointed for delivery. The under-cutting of the flutes entails

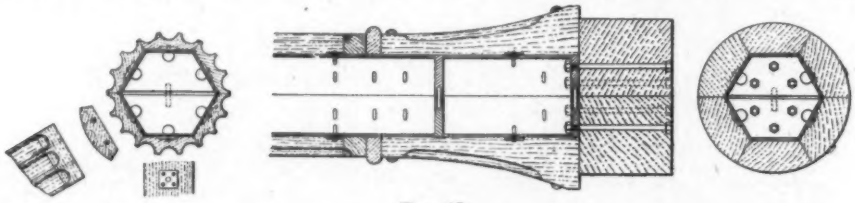


FIG. 13.

making the flutes in strips or lags separately from the main portion of the pattern, which forms a central backing, and supports the flutes. In Fig 12 this is shown lagged in wood, but instead of turning the outside, the lags are made flat, strips of parallel thickness, on the faces of which the fluted lags are fitted, The section shows six lags to the circle, but a larger number would have to be fitted in larger columns. The number of divisions must be selected not only to avoid having strips too wide, with risk of shrinkage,

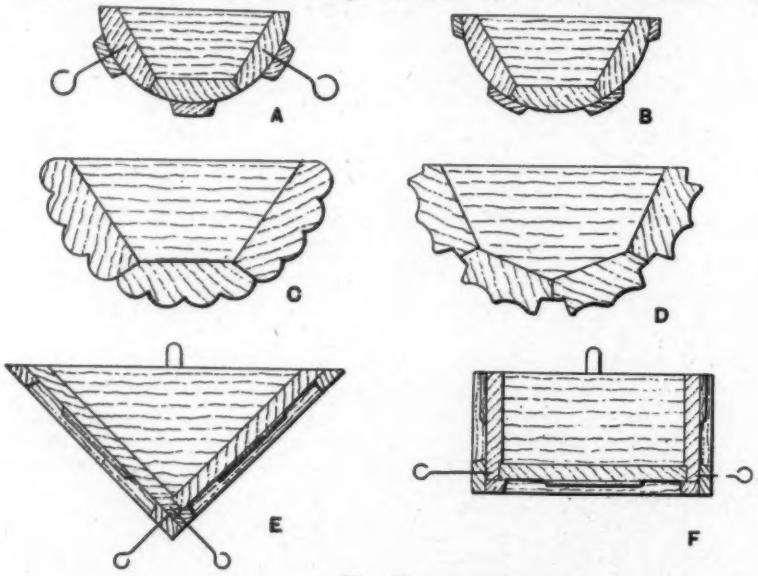


FIG. 14.

but they must be so disposed as to have no undercut. The accurate method of jointing for the particular example given is shown. The joints are not radial, but delivery of the flanking lags is provided for by the non-radial jointing shown. The flutes are screwed during rammings, with screws inserted from within, as illustrated. After the ramming has been done, these are withdrawn, leaving the lags loose, to be taken out after the removal of the central backing, the lags at the sides coming first, the bottom one afterwards.

The flutes terminate in a radius next the moulding. The portions in which the radii are cut are prepared

separtely from the lags in order to permit of planing the flutes along their whole length without any obstacle. These are screwed on the ends, and the lags screwed to the backing, and turned in the lathe. The flutes are then divided round, and marked out, the strips removed, the ends unscrewed, the flutes planed right through, the ends returned to their places, glued and screwed, and the radii worked with a gouge. The moulding is shown as cut in solid stuff. Joggles are seen skewered on, which is often done when columns are set in stones, to prevent risk of possible shifting.

Fig. 13 is a column pattern from which a large number were cast, which enabled this method of construction to be adopted Instead of lying the fluted lags on a central body of timber, a cast-iron centre was made to preserve permanence of form. The centre was cast from a pattern, and planed on the outside faces and in the joint. The method of fitting the lags is shown by the section and details at the left hand,

being in the main similar to that shown in Fig. 12. It was necessary in this case to let the square metal plates shown into the fluted strips, to receive the screws inserted from within, because wood screws strip the timber and run loose after a few insertions and removals. And instead of having heads for a screwdriver, the thumb screws shown allowed readier manipulation. The centre view shows the fitting of the capital of the column, also fluted and jointed like the lags, and secured similarly. A bead breaks joint between this and the flutes of the shaft. The fitting of the print at this end is also shown. It is made

separately, and firmly secured to the cast-iron centre with three long bolts in each half. This is the column for which the sweeping board made in Fig. 11 was used.

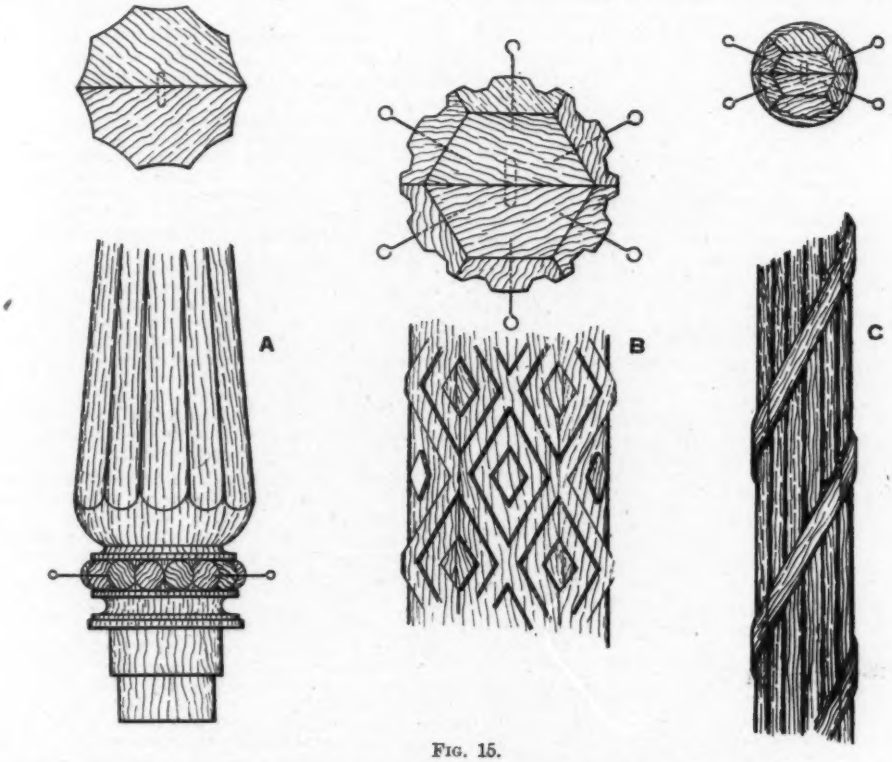
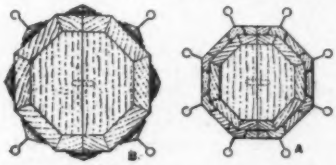


FIG. 15.

There are many other designs besides the fluted forms, several of which are seen in the groups, Figs. 14 and 15. In Fig. 14, at A and B, strips or bosses



are shown, which may, or may not, have to be left loose, according to the way in which they are disposed, relatively to the joint of the pattern. At A the two side strips must be loose. At B they can be fast, provided the taper indicated is imparted. But the joint of the pattern and mould goes through the centre of strips, leaving a joint mark on them for the fettler to remove. Very often the way of jointing is determined by other details of a column. The lags at C must be made loose in three sections. They are shown as attached to a solid centre, in which case the heads of the screws must be sunk in, or, as is frequently done, skewers are thrust from the outside into the centre. It is not well to use solid timber if it exceeds about 4 in. in diameter. At D also the four strips must be loose, those at the sides being withdrawn first, and the jointing being as shown, not quite radial. At E and F alternatives are illustrated of making a square column base. E is preferable to F as a

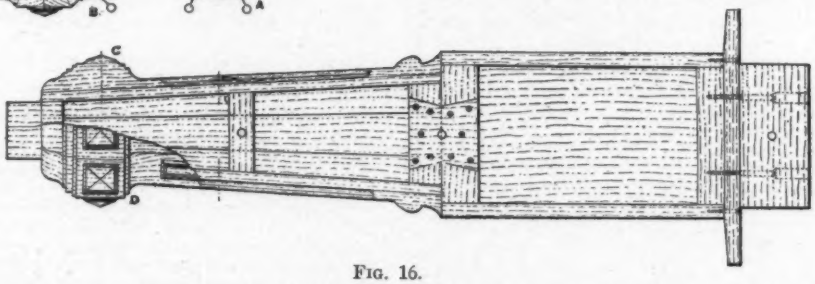


FIG. 16.

general rule, because the diagonal disposition of the sides is more favourable to delivery than the vertical sides at F. In each case portions must be left loose. But often the jointing is settled by some other portion

of the column, and then either E or F may have to be accepted.

The group in Fig. 15 shows portions of three designs of lamp columns. At A the flutes are wide and shallow, being in this respect unlike those previously shown. Each half of this pattern will deliver freely without diagonal jointing. Bosses are shown on a belt of moulding. Some of these, standing out at the sides, must be left loose. They are secured during ramming, each with one skewer through the centre. At B a diamond pattern is seen, rhomboidal, having recesses and bosses. This can be moulded by the longitudinal jointing shown. The pattern is turned and marked out, and the strips removed, and cut separately with chisels, and a router plane for the uniform depthing of the recessed portions. This is a rather troublesome pattern. The flutes are like those in C, Fig. 14, but the jointing is unequal in this case. After the flutes have been worked, the spirals are fitted to them in lengths to correspond with the joints of the fluted strips. These are then marked in place, removed, and worked separately, and afterwards screwed on permanently. Enough taper must be given to the edges to permit delivery.

Fig. 16 illustrates a rather elaborate pattern which is the lower portion of a lamp standard. The square base is prepared separately from the upper ornamental portion, and the two are united with a butt joint, and dovetails inserted in each joint face. This is secure if the jointings are close. The upper portion is lagged, the lower is boxed-up. The upper part is of fluted design, the sectional shape being seen at A. The body of the shaft is lagged with permanent joints, the flutes are formed with strips of the shape seen in the section, and all are skewered on. The upper band of ornament is cut as shown, and is seen in cross-section at B. The pattern, open in the joint face, is seen at C, and its external appearance at D.

Effects of the Chemical Composition of Electrodes on the Weld.

In order to obtain information as to the effect of the chemical composition of an electrode on the welded material in electric arc welding, tests were recently made by the Wilson Welder & Metals Company, Inc., 2, Rector Street, New York. Two electrodes of widely different chemical analyses, 0.148 in diameter, were selected and their composition determined. The analyses were as follows:—

	C.	Mn.	P	S.	Si.
R wire	0.17	0.57	0.007	0.028	0.14
W wire.. ..	0.39	1.01	0.005	0.024	0.12

The silicon content was rather high, but inasmuch as it was fairly constant in both electrodes the results are comparative.

A deposit was then made by a metallic arc, welding approximately 1 ft. long, 6 in. wide and 1 in. thick, on a ½-in. plate. The welding machine had a constant voltage of 37 volts at 130 amperes. The plates used for depositing the first layer were machined away and two test bars were made from each electrode, composed entirely of welded material. The ends were rough machined and about 4½ in. in the middle of the specimens were carefully finished. The physical characteristics of the plates were as follows :—

	Tensile strength.	Elastic limit.	Elongation.	RA.	Brinell.
R-1 ..	57,300	43,400	8.0	15 3	147
R-2 ..	56,050	50,500	6.0	5 9	132
W-1 ..	76,200	64,000	7.5	13.0	194
W-2 ..	72,650	60,260	5.5	7.1	188

After these bars were pulled, chemical analyses were taken, with the following results :—

	C.	Mn.	P.	S.	Si.
R-a ..	0.12	0.23	0.012	0.019	0.10
b ..	0.09	0.24	0.016	0.014	0.08
c ..	0.11	0.26	0.014	0.020	0.08
W-a ..	0.23	0.84	0.014	0.012	0.02
b ..	0.20	0.80	0.014	0.014	8.05
c ..	0.20	0 88	0.013	0.013	0.02

The conclusions deduced from the tests are as follows:—

It seems just as important to specify chemical composition of the electrode used in electric-arc welding as it is to specify the chemical composition in ordering any other type of steel.

Chemical composition seems to affect the physical properties in electrodes as well as other steel.

An excess of manganese seems to be needed in the electrode.

The relation between the carbon and manganese of an electrode should be approximately one to three.

High-carbon manganese wire tends not only to improve the weld on account of the amount of carbon and manganese in the welded material, but also on account of the type of structure which this wire lends to the deposited metal.

There is a smaller amount of oxide and slag inclusions with a high-carbon manganese wire than with a comparatively low-carbon manganese wire.

CONCRETE COLUMNS REINFORCED WITH CAST IRON.—An interesting series of tests to determine the relative strength of steel-reinforced concrete columns, and similar columns reinforced with cast iron, have been carried out by the American Bureau of Standards. The tests were carried out in the Pittsburgh laboratory on 18 columns. The columns were 12 in. in diameter inside 1½-in. pitch, 8-gauge wire spiral) and were reinforced longitudinally with steel rods and cast-iron pipes. The pipes located in the centre of the columns varied in outside diameter from 5 to 7 in. with wall thickness of ⅝ to 1 in. The column lengths varied from 6 to 14 ft. Tests were made on samples of the cast iron; also on the concrete used, which was proportioned by volumes and consisted of one part cement, one part sand, and two parts gravel, hand mixed. The behaviour of these columns under loading was similar to that of the ordinary type of steel-reinforced columns. Incipient failure was in all cases accomplished by scaling of the outer shell which finally spalled off at the surface of the spiral. This was followed by failure in tension of the spiral reinforcing at the maximum load sustained by the column. The maximum strength of the column is not quite equal to the strength of the cast iron reinforcement tested independently plus the strength of the usual type of spirally reinforced column. The cast-iron reinforced column has, however, a much less area of concrete. The columns commenced to scale at 70.4 per cent. of the maximum load. Two columns of the same series without cast iron commenced to scale at 89.9 per cent. (average) of the maximum. The average maximum total load sustained by the various types reinforced with cast iron and of the same length (10 ft.) as the two plain spiral reinforced columns was 81.5 per cent. greater than was sustained by the plain spiral columns. Filling the hollow core of the cast-iron tubes apparently adds 6,500 lbs. per sq. in. of cross section thus filled. In view of the general behaviour of spirally reinforced columns just preceding failure it is suggested that a superior type might be developed if the protective shell outside the spiral were applied after the column has been cast and the forms removed. This method of construction would also make possible a much greater accuracy in the placing of the spiral. The complete report of these tests contains numerous tables, photographs, and diagrams with a discussion of the design of the columns and the results obtained.

Practical Use of Denseners.

Discussion by Birmingham Foundrymen.

(*For Paper, see page 624, September issue.*)

THE CHAIRMAN said that after many years' experience of the use of permanent moulds he was convinced there was much to be gained by a careful application of denseners to thick parts of the castings. He did not so fully agree with the second half of the paper. The expansions mentioned occurred at different temperatures, the first at the separation of the primary graphite, at about 1050 deg. C.; the second at the point just prior to the freezing of the phosphide eutectic at about 900 deg. C.; and the third at 750 deg. C., at the separation of the secondary graphite. The differences that Mr. Broughall noted in his experiment were only the differences that would occur—the differences occurring in the sand moulds would occur with the permanent moulds on the same class of work. Those expansions had exactly the same effect, although they were arrived at earlier in the permanent mould because of the heat being taken out of the casting by the mould. Although the rate of cooling was much quicker, the effect was the same. He was inclined to think that the expansion, instead of being a help to cast iron, had the reverse effect. Taking for example a large chilled roll, it had been found necessary to have a sand bottom and a sand top to counter the expansion taking place, and if at the junction of the sand mould and the permanent mould any movement occurred there was a biggish fin, and it was really dangerous, sometimes causing fractures because of the lack of free expansion. Another source of danger connected with expansion in permanent moulds arose from the primary crystals, which were apt to freeze quickly at the outside chill. The expansion had a tendency to cause cleavages between those primary crystals, which could only be filled in at the second expansion, and the apertures were filled in with more brittle metal than that appearing earlier.

MR. GEORGE CARRINGTON said, although he was not a foundryman, he had derived much instruction from that very lucid paper. He differed from the Chairman as to the effect of expansion, and was disposed to agree with the author that it tended to improve the metal. The real point was not as to the stage at which the expansion took place, but whether or not that pressure, whenever it came, was or was not converted into solidification and density in the casting. That could not take place so well in a sand mould.

MR. F. JOHNSON remarked that Mr. Broughall had used the term permanent mould and not "chill" mould. Apparently he was opposed to the use of the word "chill." He remembered that, in connection with the paper he (Mr. Johnson) read before the Association two years ago, Mr. Broughall then opposed the use of the word "chill" in connection with the production of non-ferrous castings. He did not know whether Mr. Broughall still held that view. If so, he hoped he would tell them why he objected to speak of a "chill" mould for making non-ferrous castings. He was greatly interested in the account given of the use of denseners in castings having a thin and thick part, but he would like some further light on the matter. Taking as an example a two-limb casting, and assuming that the limbs were cooling at equal rates, it was possible to draw isothermal lines. Owing, however, to the fact of the heat being radiated and conducted out from the metal into the mould, they got a reinforcement of heat which prevented the portion at the corner from cooling so rapidly as the limbs. Therefore, the isothermal lines would not follow the outline of the surface, but would cross at the corner, so that, at a certain moment during cooling, the temperature of the corner would be higher than the temperature at the face of each limb of the casting. Mr. Broughall had pointed out that he experienced sponginess at some spot near the corner, and apparently it was generally nearest the thick portion. Was that correct?

MR. BROUGHALL: It is due to the thin portion cooling much more quickly than the thick portion, thereby drawing the metal from the thick portion.

MR. JOHNSON remarked that the same conditions as he (the speaker) had described obtained in Mr. Broughall's case, except that the thin limb would be cooling more rapidly and the isothermal lines would be closer together. He wanted a little more light thrown on the question if possible, because he wanted to know why they should not get a certain amount of porosity in a casting of that kind where the limbs were of equal thickness. Shrinking and contraction were taking place, and the shrinkage stress was concentrated on the portions at the angle, which were hotter than the limbs. The portion near the angle should be the last to solidify, and should tend to feed the thin portion more rapidly than the thin portion. There were at least two effects, one being the drawing away of the metal from one point as mentioned, and the other the shrinkage stress concentrated upon that point. Then also, segregation was very possible in cast-iron containing phosphorus, and the cavities might be filled with fusible phosphorus-rich segregates. With regard to the testing of Mr. Broughall's bars, he understood the compression test-piece was made from the parallel portion. That being so, those portions had been taken from parts which experienced a certain amount of strain. Would it not be better to take them from the grip portions on which there was less strain, or probably none at all? As to the ingenious test of expansion, it was clear that the mould was moved by the expansion of the metal, but was Mr. Broughall quite sure that the expansion of the mould played no part in the movement of the pencil?

MR. F. J. COOK said he was much interested in the densener section of the paper, having used denseners with very good effect for over twenty years. Mr. Broughall stated they could not use denseners with hard iron; but that was a broad term, requiring to be defined. There was really no difficulty in using iron of maximum hardness, together with maximum tensile strength—*i.e.*, of the maximum commercial hardness. For example, with a big cylinder containing 1¼ per cent. of silicon and not more than 3¼ per cent. of carbon, he had used denseners with metal of that description for over 20 years without finding any disadvantage in the way of chill. In his experience the ruling point related to the manganese. With 0.5 or over of manganese they could not use denseners, but if the proportion was below that there was no difficulty, although the metal was hard. That kind of metal broke in regular practice

at 16 to 19 tons tensile strength. Mr. Broughall mentioned the fact, though he (Mr. Cook) thought it ought to be emphasised more strongly, that denseners could be used many times over, particularly with ordinary iron. If they got blowholes, the cause of that was no doubt the expansion of the cooling iron which had a tendency to grow, and that got rid of the graphite between the crystals and oxidation took place. The metal coming against it was subject to oxidation and blowholes developed. It was very necessary also that they should be very firmly fixed. His experience was that if they got denseners not absolutely square in the mould or core they were apt to get gas jets at the junction of the sand and the denseners. With regard to hard iron, there was no difficulty whatever in using denseners in metals giving a 5/8th chill according to Keep's test. With denseners of wrought iron it was absolutely necessary to remove the black oxide of the skin; otherwise they would get the same trouble as from dirty denseners, through the decomposition of the oxide. It could be removed by pickling, machining, or grinding. It was also necessary to have an absolutely clean densener. In making big cylinders of many tons weight, in blacking the cores there was a danger of using wet blacking and so setting up oxides. Usually the best way was to rub them with sandpaper or plumbago, which was usually sufficient to prevent sticking. Mr. Broughall, in dealing with turrets, conveyed the impression that it was not possible to make turrets without permanent moulds. He (the speaker) agreed that a permanent mould produced the better job, but he had made hundreds of them without any trouble. By spinning the metal sufficiently to accumulate the scum, and with a head of sufficient and proper proportion to carry this scum, the troubles of sponginess in this type of casting were very largely eliminated.

The speaker exhibited slides showing the effect of heat treatment, and reminded the meeting that the structures of metals dealt with in the research he conducted with the late Mr. George Hailstone resembled in many respects those shown by Mr. Broughall. He found that those which gave the higher tensile strength were cast with denseners or chill or permanent moulds, and they gave a phosphide eutectic and the cementite in a network structure. Clearly, when they got those constituents in that particular form they had obtained the best form. But that structure was aided considerably by time and the rate of cooling. With regard to the expansion to which attention had been called, it was very debatable whether the results were due to the expansion Mr. Broughall had pointed out. He gave very good reasons to prove that there was that internal expansion. But expansion to such an extent must produce weakness in the bar. It all depended in that case upon the composition. He claimed, from the diagrams which Mr. Broughall had shown, that whatever might be said of other causes at work, the rate of cooling had a very marked effect, and was in fact one or the primary causes of the increase in strength and the general improvement in the physical properties of the metal. Apparently, Mr. Broughall had been converted to the drill method of testing hardness.

Mr. Broughall: I said "somewhat."

Mr. Cook, continuing, said when he (the speaker) brought forward the question of testing hardness he did not suggest it as the panacea for all trouble. But it seemed to give the general hardness better than the Brinell surface test. Mr. Broughall said also that where denseners had been applied the metal was quite easy to machine. Personally, he invariably found that where denseners were applied the presence of manganese made the metal harder adjacent to the densener, while it was softer away from the densener. He thought the explanation was that a crystalline formation was got which gave a spongy structure to the phosphide eutectic, with some hard constituents in between. The pressure squeezed the phosphide eutectic farther into the mould.

Mr. J. Shaw thought they were all agreed as to the closing effect on the structure of cast iron by the use of denseners. But there was one evil. The spongy place was often driven into the centre of the section. Mr. Broughall had said he could not use a certain class of iron. Might this not be overcome by using a thinner densener? The chilling effect would not be so great, and the re-annealing would be greater. In the cylinders Mr. Cook spoke about, probably the same idea would hold good, because the speaker did know of denseners being used with fairly high manganese iron. The higher the temperature at which both the casting and the densener attained a common temperature, the greater the re-annealing effect. Mr. Broughall's permanent moulds were all of a comparatively simple nature. The crux of the question was not "Is it possible to use permanent moulds successfully?" because Custer in particular had demonstrated that, but "Is the upkeep so great that in castings of any complication it is not a business proposition?" Would Mr. Broughall give them some idea as to the number of castings he could obtain from one mould before it was scrapped? The speaker thought that about 3,000 castings was the limit for the permanent moulds for the bomb that was made in this manner. It then became a question whether the first cost spread over that number was a paying proposition.

With regard to the difference in the breaking load for the sand-cast and the permanent-mould-cast bars, cast from the same ladle, that was easily explained. The mixture was low in combined carbon for a good test result. The quick cooling in the permanent mould closed the structure and increased the combined carbon; hence the greater breaking load. If the mixture had contained about 0.8 combined carbon, the permanent-mould bar would have contained too much combined carbon and broke at a lower weight than the sand-cast bar. The chief point was the large addition to the strength of the chilled annealed bar. The sand-cast bar on annealing, broke with a lower pull. This was what one would expect. The annealing of the permanent-mould bar increased the strength from 14 to 17 tons. This was something the speaker had not met with before, and was most interesting. Whether this was due to the release of some surface tension or other was a moot point. At the same time it must be remembered that a pull of 17 tons was quite common to a good cast iron, but certainly not of the same chemical composition as Mr. Broughall gave. The final curve shown on the screen was very instructive. Mr. Broughall had demonstrated his point that the expansion might have something to do with the density and closeness of the permanent-mould casting.

Mr. Flavell said he would like to have heard more about chilled rolls. He could quite substantiate what had been said about mysterious expansions. He had seen a chill 14 in. thick and 2 ft. deep burst its mould. The chilled roll was full of contradictions. He had seen two rolls cast out of the same ladle and the iron well mixed; one had no chill at all, and some had ¾-in chill at the bottom and no chill at the top; with a chill on one side and none on the other. It would puzzle the best man in the foundry to find out the cause. There was obviously a very wide field open for study in connection with such castings, which ought to be taken up by scientific men. It was one of the biggest industries of the country using permanent moulds, especially when they considered the size of the castings. No doubt, in the Black Country, there were two or three hundreds of tons of rolls cast every week. Undoubtedly, rolls up to 20 or 30 tons were being cast entirely by the rule of thumb.

Mr. Handforth said that Mr. Shaw had attributed the entire improvement to the increase of combined carbon; but in the annealed permanent-mould specimen the combined carbon had been reduced to 0.11 per cent., while the maximum stress had been raised to 17.4 tons. When he (the speaker) first saw a similar statement on a test made by his predecessor, he thought there was something wrong. By annealing, the combined carbon had been decreased by more than 0.5 per cent., yet an increase in strength was shown by the tensile test. He (Mr. Handforth) repeated the experiment, and he was quite as surprised as Mr. Shaw to find that the experiment was found to be correct. He would be glad to know whether anybody had found similar results. In the transverse test, the strength was increased from 27 cwt. to 34 cwt. Some light might be thrown on the subject by the point brought forward by Mr. Cook. If they examined the three photographs, there was a decided network structure in the annealed bar which undoubtedly partly explained its increased strength.

Mr. J. E. Fletcher said he had had much experience with permanent-mould work in the casting of steel and iron shells, and quite twenty years ago saw the phenomenon of liquid extrusion shown by Mr. Broughall. They knew if they could obtain metal of certain analysis that would extrude in that way they would be all right, and from such castings they never got any trouble. Undoubtedly, also, they always got improved metal from the use of chills which Mr. Broughall called denseners. The first time he was induced to use denseners was in the making of steel locomotive wheels, about 7 ft. 6 in. diameter, for express engines on the Great Northern. At first they were specially difficult, and they could not prevent their breaking during cooling. From earlier experience he decided to try denseners on the spoke ends at the junction of spokes and rim. They were immediately successful, and that was the first step towards success in wheel-centre manufacture. He preferred the word chill to densener. It meant that when they produced that improvement in structure they were really speeding-up the cooling effect at the surface of the casting, and they were getting a steep temperature gradient or chilling action through the casting, and so producing the effect so well shown by Mr. Broughall, by the increasing of the combined carbon. He was inclined to agree with the author that the speeding-up of the cooling action brought about compression, which seemed quite reasonable. They knew that at the point of freezing the permanent mould resisted the inevitable expansion, and therefore the cooling metal must be subject to compression. He had shown the effect of rapid cooling in a recent paper before the Staffordshire Iron and Steel Institute. By rapid cooling the got the Ar_1 dilatation almost entirely suppressed. They knew from Professor Turner and others that at the pearlite point Ar_1 there was a separating out of the secondary or fine graphite, accompanied by expansion. The permanent mould appeared to suppress that point and brought about the improved physical condition. It was not entirely the increase of the total combined carbon, though that was the main point, for they had the combined carbon in two or three different conditions. They had it as free cementite and in the pearlite, and, as Professor Howe had shown, they got even different conditions of pearlite by different rates of cooling. He had also often obtained an increased tensile strength by annealing oil-quenched steel, which in a sense was parallel to the "annealing-off" of the chilling effect of the permanent mould. They had heat-treated chill-cast fuse caps, and had always obtained that improvement in the tensile strength. The point that appealed to him was the rise in the compressive strength of the material. He had never seen so clear a demonstration that casting in permanent moulds really increased the compressive strength, though he thought the author had only partly explained what happened in the metal as it cooled.

Mr. Broughall, in reply to the Chairman, said he thought he had clearly proved that expansion took place on the metal immediately the metal was poured into moulds. As regards Mr. Johnson's question respecting the use of the word denseners instead of chill, the lecturer had no objection whatever to using the word chill; in fact, it was much easier to use than the word densener. But he was simply carrying out the suggestion made by some of the leading members of the Association in using the word densener instead of chill. As regards Mr. Cook's remarks respecting chill on hard mixtures, he (Mr. Broughall) was prepared to admit that Mr. Cook knew far more about cylinder mixtures than he (Mr. Broughall) did, and was quite agreeable to accept what Mr. Cook said. Respecting the remarks made by a member as to the simple form of the permanent moulds described, the lecturer advised the members not to attempt to make intricate-shape permanent moulds.

As regards Mr. Flavell's remark on chilled rolls, the lecturer had had nothing whatever to do with this class of casting, and after hearing the remarks of Mr. Flavell he hoped that he never would.

ALUMINIUM.—Aluminium in very small proportions produces a very marked effect on a bath of soft steel. Aluminium increases fluidity when working with steel low in carbon, but thickens, to a certain extent, high carbon metal. Aluminium seems to oxidise very quickly, as only traces are found in the castings by analysis. It, however, releases gases from metal through the suddenly increased fluidity, inasmuch as after the "stock" is melted, gases are then taken up by the metal. "Killing" the steel is not necessary when aluminium is properly used by the crucible process.

Cast Iron Under Heat Influences.*

By E. Adamson (Sheffield).

White cast-iron is the most dense—but the peculiar influence which heat at different temperatures exerts on the structure of the iron is not, perhaps, so apparent. It is therefore desired to consider some of the primary causes of the changes in the molecular structure—or otherwise "fracture," which is perhaps a better word to use in the case of cast-iron, because of the possible wide variation in appearance, as shown by Foster before the West of Scotland Institute in 1910, owing to the precipitation of graphite and the different forms it can take, which are so clearly discernible by the naked eye.

These are days of specialisation, and as there are five totally different uses to which pig-iron can be put, i.e., (1) steel, (2) wrought iron, (3) malleable cast-iron, (4) light castings, and (5) heavy castings, each having subdivisions, it will be understood that few men have had the opportunity of fully investigating the behaviour of pig-iron in these various operations. To one whose experience in the use of pig-iron is confined to the manufacture of steel, one can readily understand a desire to pin faith to the chemical composition of cast-iron. Although apparent in some processes of making steel, as shown by the author before this Institute in 1911, the value of fracture, as well as chemical composition, is at once apparent in puddling. The value of fracture versus chemical composition is still further evidenced in the manufacture of malleable cast-iron; for grey and mottled iron cannot be properly annealed; and finally, it is necessary to consider structure in high-class iron castings, when all kinds of physical tests are being demanded, and castings are becoming more intricate in design.

Going back to the original statement that white cast iron is the most dense, it follows that the greyer the iron the less dense and, therefore, the more open the fracture, in a general way. Of course, there are some exceptions to this rule, but these can be fully explained. Again this question of openness is not a question of chemical composition, but is largely due to temperature influences inside the blast furnace. The influence, however, of temperature in deciding the appearance of the fracture does not finish there, but continues during foundry operations, and, in fact, throughout the life of a casting exposed to heat, even when the temperature is comparatively low.

To use a simple illustration due to cooling only. When running 2 in. × 2 in. pigs in sand, the natural facture of which was practically white, one of the beds broke away and sheeted the lower one, which was left to cool overnight. Next morning the sheeted pigs were found to be a good open No. 4 grey fracture, although of the same total carbon, and the other constituents were identical. This was entirely due to slow cooling.

Again, in a much thicker section, Sir I. Lowthian Bell allowed a lump of white iron to cool slowly, and found, on breaking it in two, the centre was perfectly grey—again caused entirely by slow cooling.

Then take the case of a fire-bar which is usually cast as hard-grey as possible, because it is found that the harder the iron, keeping reasonable strength in mind, the longer the life of the fire-bar. After exposure to heat, even at a comparatively low temperature, the iron will "stretch" by reason of the precipitation of the carbon and the growth of the graphite, which latter is the cause of the distinctive feature in the different fractures of grey iron. In passing, it may be well to observe that it has now become doubtful whether the precipitation of carbon is from the carbide, or from solid solution. The latter opinion has long been held by the author, and is largely confirmed by some recent investigations by Hurst. After cast-iron has reached the limits of its "stretching" properties, it will commence to "grow," by oxidation of the iron and Silicon, and the greater the "growth" the more "rotten" a casting becomes.

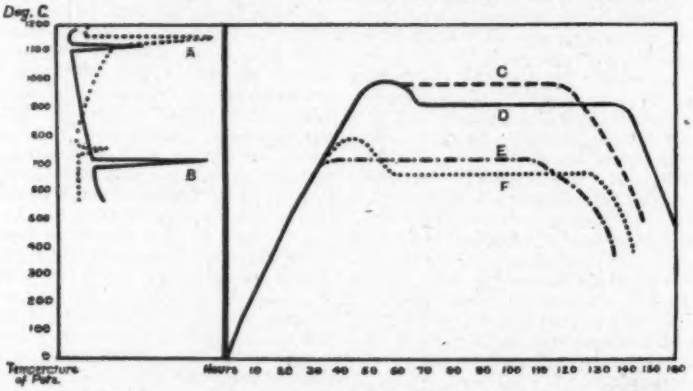


FIG. 1.—HEATING AND COOLING CURVES OF CAST-IRON, SHOWING THE TWO CHIEF POINTS OF RECALESCENCE.

Another important influence of temperature before solidification is shown by Foster, who fused iron and carbon together in a crucible at the temperature of the electric arc. The small sample was poured out on to a steel plate so as to cool rapidly by chilling. The specimen was found to have a grey fracture on a 3/16 in. section, giving G.C. 2.13, C.C. 2.54, and Si.0.098. From this it is quite evident that Si had practically no influence in producing this grey fracture; but it seems quite apparent that, having been taken to the temperature of the electric arc, the iron became supersaturated with carbon, which latter became more refractory, producing that form of graphite which tends to produce grey iron, regardless of silicon content.

As confirming this precipitation of graphite in the absence of Si., Percy, in his book published in 1864,

* Paper read before the West of Scotland Iron and Steel Institute.

gives the result of fusing oxide of iron and carbon, and, after carefully checking his results, gives the following analyses:—Iron, 95.66 per cent.; graphite, 4.56 per cent.; showing a total of 100.22 per cent. It is admitted that both these results are extreme examples of the possibilities in this direction, but, as a rule, it is from the extremes we learn the truth.

Next there is the influence of temperatures of annealing malleable cast-iron, which is a still lower temperature than any referred to above. It is well known that the American practice is to anneal at about 700 deg. C., the result being that the carbon is precipitated in a finely-divided form known as "temper" carbon, the stage preceding that of well-defined graphite; and except for the white ring of decarburised iron, the high total carbon, and consequently the high percentage of free carbon, the general structure closely resembles a No. 5 fracture of iron.

It is the British practice to anneal at a higher temperature, i.e., nearer 950 deg. C., and the result is a much more open-grained fracture than the American Blackheart shows. The point it is wished to emphasise here is that annealing at the higher temperature produces a much more open fracture in the annealed casting than the lower of these two temperatures, although there may be less total carbon present in the British or Whiteheart casting. The diagram, Fig. 1, may indicate an explanation of this: A and B are the heating and cooling curves of cast-iron, showing the two chief points of recalescence, the higher that of graphite, and the lower Ar. and Ac. 1, 2, and 3. C and D show graphically the annealing of malleable castings under British practice, whilst E and F show the American practice. Again, the reason of the alternative curves is to show that, having started annealing at a given temperature, it is possible to continue it at a slightly lower one, but for a longer time. From this figure it will be seen that American annealing practice is based upon the lower of the two critical points at which temperature "temper" carbon is formed; whilst British practice comes well on towards the higher point at which graphite is formed. Therefore, going still higher in temperature, it will be understood that slow cooling will tend towards open iron, which is rendered still more open by reason of there being no loss of graphite.

So far the author has dealt with the influence of temperature on the molecular structure of cast-iron which retains the whole, or the greater part, of the total carbon; but among his many experiments there have been two cases which are of special interest to the subject under consideration.

The one case was that of a pure white pig-iron—American washed iron—to which less than 0.50 silicon was added, and cast into a test bar 8 in × 1 in × ¾ in. This was annealed for the same period as, and alongside of, the ordinary quality of British malleable castings in the same oven. The ordinary quality casting would have about the same silicon content; but the sulphur would be anything from 0.25 to 0.50, and, after annealing, the total carbon would be about the average of say 2.00 per cent. In the case of the sample test bar, however, the total carbon was reduced to about 0.50, and the fracture of the bar was exceptionally open, showing almost spiegel-like flakes, and whilst the bar was perfectly sound it was evident that it had been very much over-annealed.

The other case was a small piece of American washed iron, containing practically no silicon, which was placed just inside the door of a Siemens furnace, then covered with dolomite, and left there for about four hours. The result was a very open and distinctly "spiegel" fracture; the carbon had been considerably reduced, and as the dolomite was not as strongly oxidising as an oxide of iron, a large proportion of the precipitated graphite was found on the surface of the piece of white iron, and also inside the dolomite covering, and this graphite was distinctly of a "refractory" character.

These two illustrations lead up to a very important consideration, that of the separation and formation of graphite, as well as that the crystallisation of cast-iron may commence whilst the metal is molten if retained for some time in the ladle. This was first mentioned by the author in his Paper before the Iron and Steel Institute in May, 1906, when Table I. was given:—

TABLE I

Hours molten.	3 hrs.	4½ hrs.	5½ hrs.
Total carbon	4.03	4.81	4.73
Graphite carbon separation ..	3.00	3.84	4.03
C.C. (by difference)	1.03	0.97	0.70
Silicon	0.024	0.04	0.07
Other impurities	Nil.	Nil.	0.005

This has since been proved in foundry practice, and is of great importance in the case of heavy iron castings, particularly when the metal has to be kept molten for some hours until sufficient is collected to pour the casting. In this case it is common practice to cover the ladle of metal with some carbonaceous material, and it is difficult to see how this can be avoided except at considerable expense, but the actual result is (1) part of the carbon from the covering material becomes intermixed with the metal, but is not necessarily dissolved; and (2) the carbon in the metal itself is being precipitated from solution, which carbon is forming graphite, which becomes refractory from continued exposure to heat whilst the metal is still molten. One result of this is that, in a thick section of cast-iron, the fracture is found to be more open than the original pig-irons used. Whilst it is quite true, as a general rule, that iron melted in the cupola becomes harder, yet this is a case where this rule does not hold good, and is one of the difficulties a founder has to meet who is unfortunate in having a heavy section in a casting, as difficulties such as dangerous "draws" are likely to arise if the iron is of a "dirty" and "sluggish" nature

The foregoing deals with the influence of temperature on molecular structure in the case of the slow cooling and annealing of cast-iron; but there is also the converse influence—that of rapid cooling or chilling. "Chilling," if the iron is sufficiently hard, prevents the precipitation of graphite, and if the iron is not sufficiently hard it may only arrest this separation, in which latter case the grey fracture of the iron would be closer than it would be by natural cooling.

The influence of "chilling" was referred to by me in 1906, before the Iron and Steel Institute, and the photograph of three chills (Fig. 2) is taken from that Paper. The analyses of the grey portion of the chills were:—T.C., 3.67 per cent.; G.C., 2.82 per cent.; C.C., 0.85 per cent.; Si., 0.98 per cent.; S., 0.11 per cent.; P., 0.05 per cent.; Mn., 0.29 per cent.

The metal was melted in a crucible and cast at three different temperatures. These were not recorded, but the first chill was cast, then in a few minutes the second, and soon afterwards the third, the metal being cast on to a 3 in. steel billet. Fig 2 shows that cast-iron, rapidly cooled by chilling, if sufficiently hard, becomes white, i.e., the carbon is retained in solution; and the three chills also show that the higher the temperature at which the metal is cast the deeper the chill.

No mechanical tests were taken of the chilling experiment, as it was simply to prove the influence of rapid cooling on the condition of the carbon; but Table II. shows somewhat remarkable results:—

TABLE II

Bars.	Cwts. per sq. in.	Deflection.	Remarks.
1" sq.	24.07	⅛" and ⅛"	All bars 12" centres and tests Average of 3 bars
0.75" sq.	26.33	3/16" and ⅛"	
0.50" sq.	28.97	¼"	
0.25 sq.	34.12	¼" and ⅛"	

Twelve bars were cast from the same ladle of metal, and were poured as quickly as possible. The analysis in this case was not taken, but the mixture usually showed approximately Si. 2.50 to 2.75, S. 0.05, P. 1.25, Mn. 0.70

In this case the ¼ in. bars were not only much closer in structure than the 1 in. bars, but were of a very fine grey texture, and except for the fact that there were not the slightest signs of the presence of cementite—the fracture might have been that of a No. 5 iron. This was undoubtedly caused by the ¼ in. bar being much more rapidly cooled than the 1 in., but the difference in tests was most remarkable, because, as the bars were reduced in size, the tests per sq. in. went up from a minimum of 24.07 cwts. in the 1 in bar to 34.12 cwts. per sq. in. in the ¼ in. bar.

TABLE III.

Analyses.	No.	Time.	Tensile.	Transverse.	Deflection.	Moment of resistance.	Remarks.
T.C. 3.76							
G.C. 3.10			Tons per	Cwts.		Tons per	
C.C. 0.66		Hour.	sq. in.		In.	sq. in.	
Si. 1.30	1	3.40	16.21	32.66	0.343	20.40	Very hot.
S. 0.114	2	3.45	14.79	31.00	0.347	19.52	Fairly hot.
P. 1.14	3	3.50	Unsound.	28.00	0.291	17.70	"Thick" metal.
Mn. 0.54	4	3.55	Do.	28.66	0.294	17.90	Very thick metal.
In this particular case there appeared to be practically no difference in the C.C. of the bars 1 to 5.	5	4.0	Do.	23.66	0.258	14.90	Do. do.

One more instance of the casting temperature will be interesting. A ladle of metal was cast at five different temperatures, but as the pyrometer did not register the temperature satisfactorily the bars were cast at five minutes' intervals, with the results as shown in Table III.

This is an excellent illustration of the influence of casting temperatures on the physical tests of cast-iron, and, if the best results are desired, it shows the necessity of casting as hot as possible. In this particular

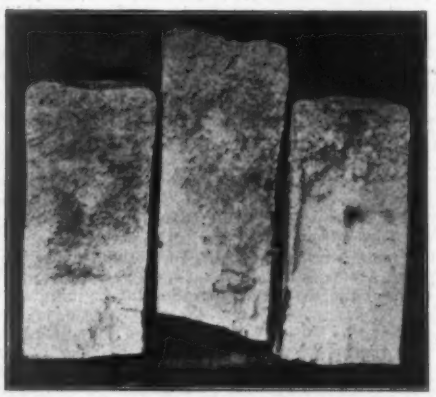


FIG. 2.—CAST-IRON RAPIDLY COOLED BY CHILLING.

case also the bars cast first and second were perfectly sound at the fracture; but the other three were not sound, particularly the last one. It is not suggested here that casting temperatures are alone responsible for unsound castings, as the author can well conceive there are irons of such physical properties that they can be cast sound at a lower temperature, which in the case of a "dirty" iron would give unsound results.

In the case of tests, however, the author had one investigation in which the usual results obtained from a certain mixture gave 11 tons tensile with regularity. In this case the bars were cast separately, but when the test bars had to be cast on the casting the result dropped to under one-half. The explanation was that the bars had been cast on the "boss" of the propeller, and by excessively slow cooling—virtually annealing at high temperatures—the fracture of the test bar had become quite grey and open through the growth of the graphite.

Similar molecular changes also take place in steel under heat-treatment, but they are not so apparent to the naked eye, and are not so pronounced as in cast-iron. The reason the changes are more pronounced in cast-iron is that there is usually present 3 to 4 per cent. of carbon, and the changes in structure and fracture which are possible through the precipitation of the carbon as temper-carbon or graphite, and its consequent growth, make the study of cast-iron a very complex question, particularly as the eye must be relied on in the iron foundry to a much greater extent than in a steel works.

MODIFIED ROSENHAIN FURNACE.—In a Paper read before the Institute of Metals in 1915, Dr. W. Rosenhain described a new type of furnace designed primarily for the thermal analysis of metals by the inverse-rate method and used by him in the metallurgical department of the National Physical Laboratory with considerable success. He pointed out some difficulties met with in its operation, such as uniformity of rate of heating or cooling being inadequate for the degree of accuracy desired. To overcome this difficulty he suggested, in place of motor propulsion, a gravity drive controlled by a hydraulic cylinder with a relief valve whose width of opening could be regulated to allow of any desired rate of motion. Mr. H. Scott and Mr. J. R. Freeman, Jun., both of the U.S. Bureau of Standards, in constructing a thermal-analysis furnace of the Rosenhain type, have therefore followed his suggestion and also added certain features that increase somewhat the convenience and simplicity of its operation. Requests for information regarding this furnace and the highly satisfactory results obtained from its use induced the authors to describe its construction and operation in sufficient detail to make possible its duplication or improvement. Their joint Paper was presented to the American Institute of Mining and Metallurgical Engineers at Chicago in September. The furnace is heated at the top, as is Dr. Rosenhain's, to avoid convection currents, but the sample in its containing tube is introduced from the bottom, or cold end. This removes the disadvantages of his method, which consist of inconvenience in position of the sample and control apparatus and the heating of some part of the sample tube at all times to the maximum temperature of the furnace. The latter disadvantage may prove serious in the event of slight inhomogeneities in the thermo-couple wire.

Foundry Electric Furnaces.

In a recent paper on "Electric Furnaces and Steel Making," read before the West of Scotland Iron and Steel Institute, Mr. Victor Stobie made some important references to the employment of electric furnaces in the foundry. The writer states that in steel foundries the electric furnace has found either a most happy home or the extreme reverse. Electrical steel for castings offers several pronounced advantages over other steels. When poured it is quieter in the mould, and does not easily cause the sand to burn on. Quiet metal also gives much less trouble on cooling, and seldom pulls. The comparative freedom from sulphur of electric steel is another excellent help against cracks in castings. Where an electric furnace has been a failure in a steel foundry, the onus has almost always fallen on the installation itself. The fault may have been with the furnace proper or with the general lay-out of the plant, but such defects must not be confused with the merits of electric steel as steel, any more than one would nowadays condemn steam as a motive power because a particular steam engine was badly designed.

When installing an electric furnace, the following observations should be kept in view :—

1. There must be plenty of room for the furnace operators all round the plant.
2. The furnace should not be in a stagnant atmosphere.
3. The transformer chamber should be below furnace level when possible, so as to avoid the near presence to the furnace of the chamber walls, which would tend to confine heat around the plant.
4. When feasible, the furnace is best at an elevation above ground level with a stage erected as furnace platform for the melters. This arrangement reduces the cost of removing slag; facilitates better attention to the tilting gear and the underneath parts of the furnace; provides warm storage for refractories underneath the stage; and avoids excavating for a transformer chamber.

Whether the plant is for making ingots or castings, a low cost of operation is essential. The items of cost, which vary on different plant, are—current consumption, electrode consumption, refractories, general renewals, and speed of working.

Affecting the cost of production is the very great factor of continuous operation; in other words, yearly output of steel. The speed of an odd heat, or even a twenty-four hours' record, is no evidence whatever of the prime commercial factor of annual output. The weight of good steel manufactured per hour is the index of the real speed of working and of total delays. Some delays may, of course, result from matters not arising on the furnace installation, and then cannot be taken into full consideration; but delays on the installation itself, including those for repairs and renewals, are a valuable indication of the relative commercial value of different furnaces. The engineering skill displayed in the design of each portion of the plant should be carefully looked into. Special regard should be paid to the strength, rigidity, and safety of such vital parts as the electrode gear, tilting gear, transformers, and switch gear. As the necessary lowering and re-gripping of the electrodes in their holders is an operation which delays production, an important matter is to investigate the length of the free vertical travel provided for the furnace electrodes, and the rate at which the electrodes are consumed greatly influences the periods between adjustments.

Electric furnaces are serviceable for any output of steel required, from 10 tons per week upwards. A five-ton furnace will yield 30 tons of steel per 24 hours, or it may be worked during the day only, should night work not be desired. A 10-ton furnace will yield up to 250 tons of steel per week. A 15-ton furnace will give 360 tons weekly. Stobie furnaces may be worked at reduced capacity should less steel be required at any time. Their efficiency is reduced only slightly by this procedure, when fitted with economisers. One can usefully subdivide electric furnaces according to size, into large ones and small ones, taking the small class to include those up to six tons, and the large class from seven tons upwards.

The proportion of the weight of the furnace structure to the weight of the charge in small furnaces is often six to one; whereas in the case of large furnaces it is down at times to a proportion of three or even two to one. This means that much of the heat developed in the small furnace is devoted to keeping the fabric hot, and it is for this reason often found a distinct advantage to heat by separate means the hearth of the furnace at the same time as the steel charge is being heated, in order that the large abstraction of heat from the molten bath by the hearth will not chill the bottom layers of the steel. The importance of this will be realised when considering high-percentage alloy steel making, as, unless an equable temperature is obtained throughout the mass of the charge, any of the alloys at the bottom of the bath will tend to remain there on account of their greater specific gravity when cold than when hot. This reaches a maximum of importance in such steel as high-speed steel, where the heaviest material (tungsten) of the charge weighs three times as much as an equal volume of molten steel. In this particular case the disadvantage of a cold hearth is further aggravated by the melting point of the tungsten being much higher than that of steel. This example will make clear what mostly takes place in small electrical steel furnaces heated only by arcs above the bath. Larger sizes of furnaces do not require any bottom heating on account of the greater weight of steel bath, therefore its presence in such cases is wasteful and an unnecessary addition. In the largest furnaces, bottom heating would be a most serious source of danger on account of the heavy currents which would have to pass through the hearth, and is utterly inadmissible.

During the subsequent discussion, Mr. Sharpe said it would appear that the metallurgist had done his part of the work most satisfactorily with the assistance of a thorough electrical experience, but insufficient care had been given in many cases to the construction of the furnace shell, tilting gear, and electrode operating gear. With regard to the electrode consumption, his firm were running three different types of furnaces using graphite electrodes varying from 4 in. to 8 in. They found that the 4-in. electrodes with a high voltage operating single phase had a low electrode consumption from wearing, but the number of breakages of the small electrodes at the nipple brought the average well up and sometimes over the 8-in. electrodes.

Stress-Testing Machines.

A Progress Report has recently been issued by the Committee of the Engineering Section of the United States National Research Council, dealing with "Fatigue Phenomena in Metals." Some interesting details of stress-testing machines are given in the course of the Report, from which we give the following abstract:—

Metal parts of machines, such as springs, shafts,

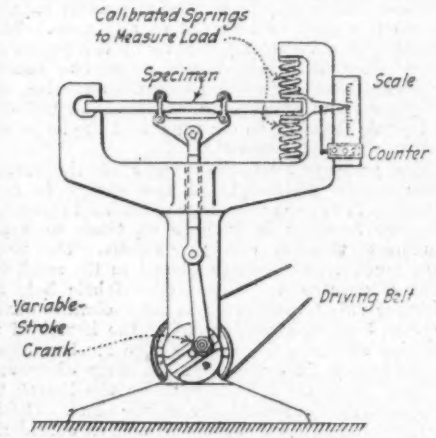


FIG. 1.—A TYPE OF REPEATED-STRESS TESTING MACHINE.

crank-pins and axles, occasionally fail suddenly while only subjected to conditions of ordinary service. Not only does failure occur suddenly, but the part about to fail shows no ordinary evidence of weakness. The broken parts when examined are seen to be broken off short, and without general distortion, even though the material may show high ductility in ordinary tests. The phenomena which are involved in the final failure of metal through oft-repeated loading is generally known as "fatigue."

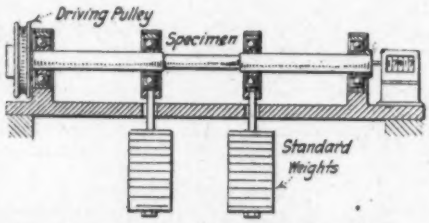


FIG. 2.—TYPE OF MACHINE FOR DETERMINING REVERSED BENDING STRESSES.

The phenomena of fatigue failure have recently given rise to some perplexing problems in connection with the design and service of aeroplane-engine crankshafts, the hulls of steel ships, axles and shafts in railway cars, motor cars and trucks, and other machine parts. The question whether structural parts subjected to repeated stress are in danger of fatigue failure has been discussed at considerable length. The danger of fatigue failure seems to be an unimportant factor in determining the safety of structural parts, with the possible exception of parts subjected to reversal of stress. The reason for this is probably found in the relatively small number of loadings which most structures are called upon to withstand, and in the fact that most of the loadings are below the maximum safe working value. On the other hand, the danger of fatigue failure is a major factor in determining the safety of many machine parts.

Fatigue tests cannot readily be carried out with

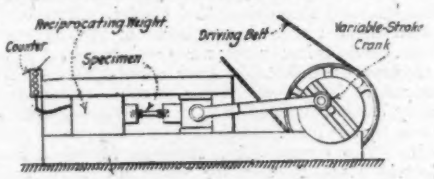


FIG. 3.—BRITISH FORM OF REPEATED-STRESS TESTING MACHINE.

ordinary "static" tensile testing machines. It is, of course, possible to make repeat loadings on a test specimen in such a machine, but the progress is very slow. Such a machine equipped with an ingenious automatic arrangement for applying and releasing load was used

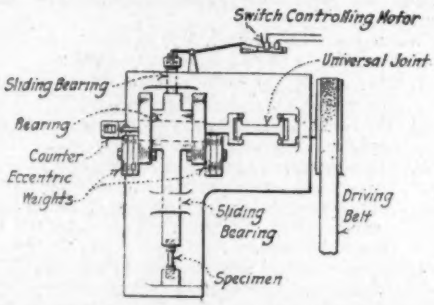


FIG. 4.—SPECIAL FORM OF REPEATED-STRESS TESTING MACHINE.

by Van Ornum in fatigue tests of concrete in compression, but the time required for even a hundred thousand reversals of stress was very great.

A common type of repeated-stress testing machine is one in which a calibrated set of springs resist the

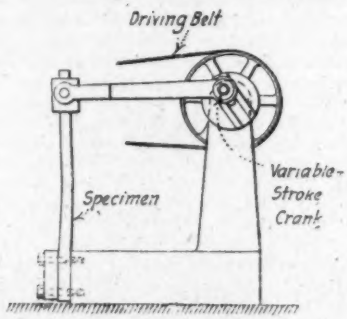


FIG. 5.—SHORT TIME REPEATED-STRESS TESTING MACHINE.

tensile, compressive, flexural, or torsional stress set up in the specimen, and the deformation of the calibrated set of springs gives a measure of the force or moment acting on the specimen. Fig. 1 diagrammatically illustrates this type of machine which was used by Wöhler

and has since been used by many other experimenters. The Upton-Lewis machine is of this type and extensive use was made of it in torsion tests carried out by McAdam. This type of machine permits a fairly high rate of alteration of stress, and machines which have been run at 1,000 repetitions per minute have given results apparently trustworthy.

The most common type of machine for reversed bending stresses uses a circular specimen acting as a rotating beam. This type was used by Wöhler, and also by many later investigators. Fig. 2 illustrates such a machine. The specimen is in the form of a bar of circular section, to which bending stress is applied by weights. The specimen is rotated by means of a pulley. At any instant the outer fibres are subjected to a stress varying from tension on one side to compression on the other, and the fibre stress at any point passes through a cycle of reversed stress during each revolution. As shown, the specimen is loaded at two symmetrical points of the span, and between these two points the extreme fibre stress is constant for each element along the bar. This type of machine permits high speed of reversal of stress, speeds up to 2,000 r.p.m. having been successfully used.

British experimenters have used repeated-stress testing machines, in which varying stress was applied to a specimen by means of the inertia of reciprocating parts Fig. 3 shows such a machine, which can be used at high speeds. However, the speed must be very closely controlled, as the inertia forces vary with the square of the speed. Moreover, friction on the guides causes some slight uncertainty as to the magnitude of stress set up at each stroke of the crank.

A repeated-stress testing machine depending on centrifugal force to produce cycles of stress is shown in Fig. 4. It is evident that as the eccentric weights revolve the specimen will be placed alternately in tension and in compression. The characteristics of this machine are much like those of the inertia type; in fact, it is a special form of inertia machine. A type of machine used by Arnold, and later by other experimenters, is shown in Fig. 5. In this machine a specimen is repeatedly subjected to deflection of a given amount. Usually this deflection is sufficiently large to stress the material well beyond the elastic limit, and no very definite stress value can be computed. This machine is used mainly for short-time tests. Another short-time-test machine uses the repeated impact of a small hammer. The claim is made that impact-loading emphasises local flaws better than a load which is more gradually applied, and that thus it indirectly gives a better index of fatigue strength. Data, however, are lacking to prove or disprove this claim.

Various repeated-stress-testing machines have been constructed in which the cycles of stress were set up by the action of an electro-magnet energised by alternating current. Usually the stress was measured either by the deflection of a spring or by the deformation of a standard test bar attached to the specimen. The speed of such a machine, however, is usually so high that there seems to be some uncertainty as to whether the successive waves of stress pass through the specimen without interference.

AMERICAN MOTOR INDUSTRY.—At the beginning of the year, as we learn from a recent issue of the Board of Trade Journal, 5,945,442 motor cars and trucks were in use in the United States, which means that there was one vehicle for every eighteen persons in the country. In 1917, the value of the commercial motor cars exported from the United States was $36,755,836, France being a buyer to the extent of $8,496,861. and the United Kingdom to the extent of $20,356,879; in 1918 France imported to the value of $12,920,029, and the United Kingdom to the value of $6,671,290. the United States export for the year being $26,814,952. About 60 per cent. of the commercial machines exported in 1918 went to Europe.

Marine Gasoline Engine Cylinders.

The relative merits of hard or soft iron for cylinders has been a moot point in the past among steam-engine builders, says a writer in a recent issue of "The Foundry." Those supporting the latter contention say that cylinders made of soft iron soon become glazed from the action of the piston and naturally work easier than those made of hard iron; but the others claim that a cylinder made of soft iron is almost certain to be spongy. Strong iron as hard as can be machined seems to give the best satisfaction in cylinders for marine gasoline engines. It must be strong since the engine has to be made as light as possible; it must be hard, and of fine close-grained iron, to withstand wear. The transverse breaking strain of the iron in these cylinders should be between 3,300 and 3,600 lbs. when the test is made on the American Foundrymen's Association standard arbitration bars. Dry-sand moulds will give cleaner and smoother castings than green sand, but it is a more expensive method and is only used on the larger sizes of marine engines. If fine close sand could be used, the green sand would give just as smooth a skin; but unfortunately the very fineness of the sand interferes with the gas escaping from the mould. Mechanical analyses of moulding sands indicate that the voids in fine sand are relatively larger than in that of coarser grades, but actual practice demonstrates the fact that the gases escape more readily through coarse sand, and therefore sounder castings are produced with this material. The sands used for cores are usually lake or beach sand since a clean washed sand is one of the prime requisites of success on the jacket and smaller cores. The barrel core may be of different sand. Washed sand gives the best results. It is free from clay and other foreign matter which only tends to absorb binder. This sand contains nearly 90 per cent. silica; therefore cores made of it resist the intense heat of the iron without fusing. There is no need of blacking, as they are easily cleaned out and leave a very smooth surface. Oil binders are generally used on this class of work. When the proper proportions of oil and sand are used, a very strong open core is the result, requiring very little rodding. The venting is nearly automatic and the gas escapes very readily. Good results are obtained from a mixture consisting of one part of oil to 45 of beach sand. In order to obtain cores true to size it is advisable to use metal dryers. Founders are aware of the wedging strain of iron and how it finds its way between two cores. It is very important that this should not take place in these cylinders. There must be an uninterrupted circulation of water around the barrel while the engine is running; therefore the two half cores for the jacket must be brought into intimate contact along the joint. To achieve this, a thin mixture of putty is applied to the joint of the core; or flour mixed with oil may be used. In some of the larger sizes a putty worm is laid between. On the still larger sizes the joint of the jacket core is usually filled with sand and dried with a torch. Steel chaplets should not be used in marine engine work, as the salt water soon corrodes them and leaks develop. Copper rivets will prove satisfactory on light cylinders with thin walls. It is not necessary to make the stem of steel. Take a steel or iron rod and bore a hole in the end, in this insert the copper rivet or nail. If the iron is good and hot it will partly fuse the copper and make an absolutely tight joint.

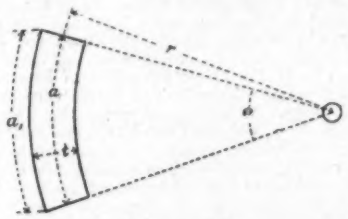
CAST IRON.—Grey or white iron suitable for casting is made by adding carbon and silicon, usually in the form of ferro-silicon or carborundum, to steel turnings or scrap and melting in an electric furnace, preferably lined with silica. The resulting iron may contain up to 5½ per cent. of carbon and up to 5½ per cent. of silicon, and samples contain (1) 3 per cent. of carbon and 2 per cent. of silicon, and (2) 4 per cent. of carbon and 2 per cent. of silicon.

Method of Calculating Stress in Curved Rings.

HATFIELD AND THIRKELL.

In a Paper entitled "Season Cracking," given by the authors at the recent meeting of the Institute of Metals in Sheffield, and of which we publish an abstract elsewhere in this issue, the following method of determining the circumferential bending stresses existing in rings cut from a cylindrical article was given. This method was applied by the authors to determine the internal stresses due to cold work in "spun" brass bowls. The method is applicable to the determination of stresses in other ring-like forms, and on this account, for the information of our readers, we publish the full method of treatment of this problem below.

The fact that rings parted off from the bowl, and afterwards cut, open out to a larger curvature, proves that when in their positions on the bowl the material is only kept in the shape which then obtains by the constraint put upon it by the neighbouring parts. Thus there may exist compression or tension circumferentially or vertically, as well as bending stresses in both directions. By cutting up the bowl in various



ways and observing the change of shape on small pieces on freeing them from the remainder of the bowl, the stresses in these different directions can be estimated.

Of these, the circumferential bending appears to be the most serious, and the calculation which follows is based on simple bending of the horizontal rings, other stresses being neglected. The presence of the other stresses would modify slightly the actual resultant stress at any point, increasing it in some cases and reducing it in others.

Since the application of the formula deduced requires a knowledge of the value of the modulus of elasticity of the material, this value was determined by a deflection experiment, using a strip of the material supported at each end and having known weight hung from the middle. The value deduced was 7,500 tons per sq. in.

(1) Piece naturally straight, bent to the arc of a circle of radius r (Fig. 1), assuming the stresses to be within the elastic limit.

t = thickness. r = radius of curvature at centre line.

E = modulus of elasticity. ϕ = angle of deflection in radius.

a = length of arc. $a = \phi r$ . . . . (1)

For the outer surface, a becomes a_1 after bending.

$$a_1 = \left(r + \frac{t}{2}\right)\phi$$

$$\therefore \text{Increase of length} = a_1 - a = \frac{t}{2}\phi$$

$$\text{But } E = \frac{\text{stress}}{\text{strain}} = \frac{\text{load per unit area}}{\text{elongation} \div (\text{original length})}$$

$$\therefore \text{Stress} = \frac{E \times \text{elongation}}{\text{original length}}$$

$$\text{Stress} = \frac{E \times \frac{t}{2}\phi}{r\phi} = \frac{Et}{2r} \quad . \quad . \quad . \quad . \quad (2)$$

(2) Piece naturally curved, but kept to a different curvature by some means.

$$\text{Stress} = \frac{Et}{2} \times \text{change of curvature}$$

$$= \frac{Et}{2}\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

$$= \frac{Et}{2}\left(\frac{r_1 - r_2}{r_1 r_2}\right)$$

If W = width of opening (measured along the arc of the circle) after releasing the stresses.

$$W = 2\pi r_1 - 2\pi r_2 = 2\pi(r_1 - r_2)$$

$$\therefore \text{stress} = \frac{Et\,W}{4\pi r_1 r_2}$$

The Institute of Costs and Works Accountants, Limited.

With the object of promoting the higher efficiency of those engaged in this special section of manufacturing, this organisation has been formed for assisting its members by mutual interchange of information and ideas, and to also secure for them a definite professional status.

A system of examinations has been arranged, which all members must pass to ensure their proficiency in practical and technical details arising out of their occupation. The scheme of examinations has been laid out as far as possible on the most necessary basic principles of costing, together with individual attention to the greater branches of industries, such as engineering, shipbuilding, mining, textile, chemicals, buildings, and other important industries. It is the Institute's intention to provide in London and the chief provincial towns necessary reading rooms and reference libraries, and, further, lectures will be arranged during certain periods of the year to set forth any advancement or new methods that might be adopted with advantage to the members generally.

Provision has also been made to enable those desirous of qualifying to enrol as "Student Members" during such time as they are studying for the examinations.

ELECTRIC FURNACE PRODUCTION IN GERMANY.—With the Allied occupation of the right bank of the Rhine and the separation of German Lorraine, Germany has lost important plants producing electric steel, according to "Le Luxembourgeois. In Lorraine the Thyssen-Hagendange steel plant had two 8-ton Heroult electric furnaces and one of 20 tons. The Rombach plant had one 2-ton Heroult furnace. The Röchling-Rodenhausen plant in the Saar basin and the Stumm plant at Neunkirchen had each an 8-ton Nathusius electric furnace. It is estimated that the number of electric steel furnaces in Germany was 90, of which 10 lay in the occupied territory. The production of electric steel rose from 131,597 metric tons in 1915 to 190,036 in 1916, to 219,700 tons in 1917, and to 265,472 tons in 1918.

Investigations into the Hardness of Cast Iron at Different Temperatures.*

By M. Leon Guillet.

The author, who points out that cast iron is widely used for piercing-tools in shell manufacture, states that, in the course of a prolonged series of researches into various questions arising from the manufacture of shells, the question of

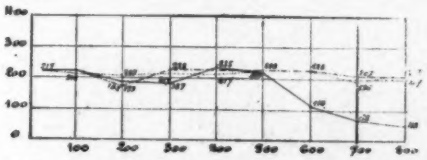


FIG. 1.—ORDINARY CAST IRON—SAND CAST.

the use of cast iron, amongst other materials for piercing-tools, received considerable attention. One important establishment which made large quantities of shells in pre-war times, always used a cast-iron piercing-tool of the

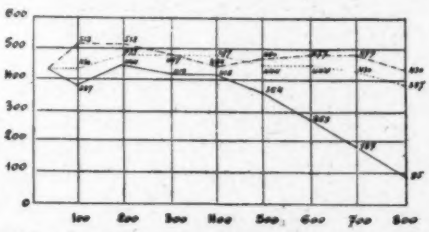


FIG. 3.—CAST IRON CONTAINING 25 PER CENT. STEEL —CHILL

following average composition:—Carbon, 3 to 3.3 per cent.; graphite, 2.9 per cent. (in the body of the tool); silicon, 0.7 to 0.9 per cent.; manganese, 0.2 to 0.4 per cent.; sulphur, 1 per cent.; phosphorus, 0.8 per cent.

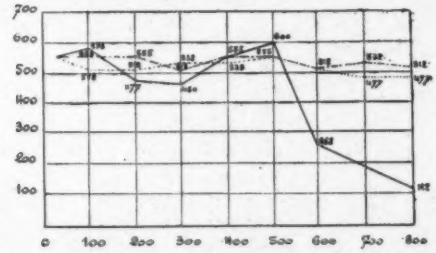


FIG. 5.—CAST IRON CONTAINING 0.5 PER CENT. TIN— CHILL CAST.

In normal times the average production per tool was from 500 to 600, but the production has not exceeded an average of 300 during the war.

Other works utilise a cast iron containing steel and obtain a life of 500 to 600 operations; generally these tools give way with something like 300 operations.

Several works use a comparatively pure cast iron to which a considerable quantity of manganese is added. The approximate analysis of this material

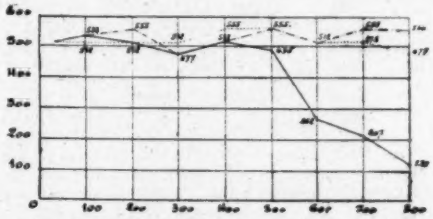


FIG. 2.—ORDINARY CAST IRON—CHILL CAST.

is as follows:—C, 3.0 per cent.; Mn, 3.0 per cent.; Si, 1.0 per cent.; S, 0.03 per cent.; P, 0.10 per cent. The methods of tool manufacture and their subsequent treatment was found to vary greatly in different works; some used ordinary sand-moulded

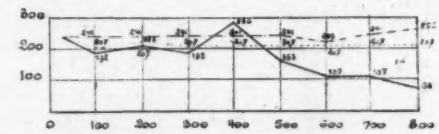


FIG. 4.—CAST IRON CONTAINING 0.5 PER CENT. TIN— SAND CAST.

tools; others, a tool having a chilled-cast nose, while several subjected the cast iron to a heat-treatment operation in which the tools were reheated to approximately 750 C. (without any precision) and quenched. In view of this varied practice it is not surprising that the behaviour of cast-iron piercing-tools should have been found to be very irregular. A considerable amount of research into the properties of cast iron for pierc-

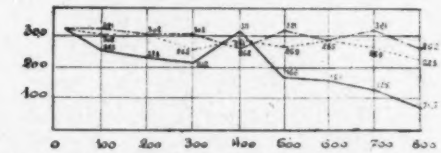


FIG. 6.—CAST IRON CONTAINING 1 PER CENT. TIN— SAND CAST.

ing-tools used in shell manufacture is still considered necessary.

In this particular research the variation of the hardness of the different materials used for the manufacture of these tools with the variation in temperature was systematically studied, and the important results obtained on different varieties of cast iron utilised in this connection are of considerable interest. The experiments were carried out on ordinary cast iron, cast iron containing steel and cast-iron containing tin.

* Extract from the Revue de Metallurgie. May, 1917. "Researches on the Manufacture of Shells."

The results obtained on the various samples studied are diagrammatically illustrated in Figs. 1 to 11. In these diagrams the vertical ordinates represent the Brinell hardness figures, and the abscissai the temperature of the experiment. The chain-dotted lines represent the hardness of the normal sample before the experiment, the thick continuous line the hardness at the different tem-

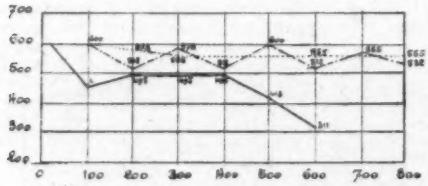


FIG. 7.—CAST IRON CONTAINING 1 PER CENT. TIN—CHILL CAST. AT 700 DEG. AND 800 DEG. THE SAMPLES FRACTURED.

peratures, and the dotted line the hardness of the sample after cooling down to normal temperatures.

Ordinary Cast Iron.

The first sample studied was an ordinary cast iron after cooling in sand and in a chill respectively. The analysis of this cast-iron was as follows:—C, 3.3 per cent.; Mn, 1.2 per cent.; Si, 1.6 per cent.; S, 0.05 per cent.; P, 0.13 per cent. The sample cooled in sand showed the following pro-

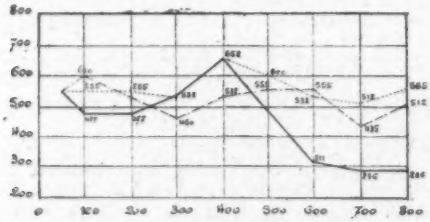


FIG. 9.—CAST IRON CONTAINING 2 PER CENT. TIN—CHILL CAST. AT 800 DEG THE SAMPLE FRACTURED.

portions of combined and free carbon on the surface:—CC, 0.48 per cent.; Gr, 2.80 per cent. The chilled sample contained no free graphite.

Cast Iron containing Steel.

The cast iron used in this investigation contained 25 per cent. steel, its chemical composition being as follows:—C, 2.96 per cent.; manganese, 0.99 per cent.; silicon, 0.42 per cent.; sulphur, 0.123 per cent.; phosphorus, 0.112 per cent.

The results obtained are graphically illustrated in the curves shown in Figs. 1, 2, 3 respectively. The results expressed in these diagrams are summarised in the following table:—

TABLE I.

Sample.	Hardness normal.	Temperature at which the hardness diminishes.	Hardness at 800°C.	Hardness after Experiment.
Ordinary cast iron:				
Cooled in sand ..	196-228	600°C	48	207-228
Chilled	512-555	600°C	121	477-555
Cast iron, containing steel:				
Chilled ..	387-477	500°C	95	430-512

It is worthy of note that the normally-cooled sample of cast iron preserved its original hardness after the experiment.

These experiments go to prove that cast iron containing steel is inferior to ordinary cast iron in that the hardness commences to decrease at a lower temperature and the final value at 800 deg. C. is also lower.

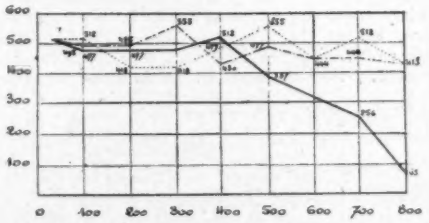


FIG. 8.—CAST IRON CONTAINING 2 PER CENT. TIN—SAND CAST.

Cast Iron containing Tin.

It is well known that the presence of tin hardens cast iron, and doubtless this is due to the presence of a compound of iron and tin which the author has previously shown to exist in steels containing tin. An extended study of the influence of tin on the hardness was made both in connection with ordinary cast iron and cast iron containing steel.

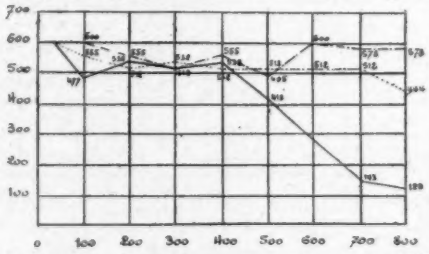


FIG. 10.—CAST IRON CONTAINING 5 PER CENT. TIN—SAND CAST.

The chemical composition of the samples is given in Tables II. and III.

TABLE II.—*Ordinary Cast Irons containing Tin.*

	Samples.	Sn.	Tot.C	Gr.	Si.	Mn.	S.	P.
1	Cooled in sand ..	0.28	3.3	2.7	1.46	1.10	0.04	0.15
	Chilled	0.31	3.4	traces	1.45	1.10	0.04	0.14
2	Cooled in sand ..	1.07	3.5	2.6	1.55	1.37	0.06	0.14
	Chilled	1.07	3.5	traces	1.53	1.48	0.05	0.12
3	Cooled in sand ..	1.94	3.3	2.4	1.36	1.27	0.05	0.10
	Chilled	1.87	3.2	traces	1.30	1.27	0.06	0.15
4	Cooled in sand ..	4.64	2.9	2.2	1.27	1.21	0.04	0.14
	Chilled	4.55	2.9	traces	1.27	1.27	0.06	0.13

TABLE III.—*Cast Irons containing Steel and Tin.*

5	Cooled in sand ..	0.54	2.8	traces	0.28	0.94	0.11	0.14
	Chilled	0.46	2.5	traces	0.33	0.88	0.12	0.14
6	Cooled in sand ..	0.88	2.4	traces	0.37	1.05	0.10	0.08
	Chilled	0.91	2.5	traces	0.37	0.77	0.10	0.08

It should be noted that samples Nos. 2 and 4 failed in the high-temperature experiments, as is indicated in the diagrams (Figs. 7 and 11).

The results obtained on these samples are expressed diagrammatically in Figures 4 to 11.

From a comparison of these results summarised in Table IV. with those obtained on the samples without tin, it will be seen that the presence of tin in the iron raises the hardness both at normal temperatures and at 800 deg. C. Ordinary cast iron at 800 deg. C. gives a figure of 48, whilst iron with 1 per cent. tin at the same temperature gives a figure of 72, whilst 5 per cent. tin gives a figure

TABLE IV.

		Hardness before Experiment.	Temperature at which the hardness diminishes.	Hardness at 800°C.	Hardness after experiment.
1	Cooled in sand	207-288	500°	68	223-255
	Chilled.. ..	477-555	600°	112	512-555
2	Cooled in sand	228-302	500°	72	262-321
	Chilled.. ..	555-600	500°	311 at 600	512-600
3	Cooled in sand	418-555	500°	68	418-455
	Chilled.. ..	512-652	500°	286	435-600
4	Cooled in sand	444-600	500°	126	495-600
	Chilled.. ..	555-600	500°	126	600-946
5	Cooled in sand	321-364	500°-600°	163	364-444
	Chilled.. ..	387-512	300°-500°	112	430-512
6	Cooled in sand	302-364	500°	116	364-444
	Chilled.. ..	418-444	300° to 500°	116	418-444

round about 126. From an examination of the results of this investigation it would appear that the addition of tin to grey cast iron in quantities

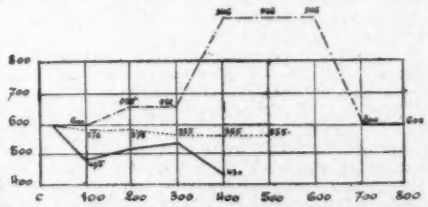


FIG. 11.—CAST IRON CONTAINING 5 PER CENT. TIN—CHILL CAST.

up to 5 per cent. would be a desirable addition to castings which are required to maintain a considerable degree of hardness at comparatively high temperatures.

"THE OCCLUSION OF GASES BY METALS."—The Faraday Society have now published in their "General Discussions" Series a reprint (from the "Transactions" of the Society) of Sir Robert Hadfield's introductory address on "The Occlusion of Gases by Metals," followed by seven Papers by different authors on the same subject, and the discussion which followed thereon. Price 8s. 6d.

RHENISH FOUNDRYMEN'S ASSOCIATION.—The Rhenish Engineering Foundries' Association has been formed, as a sub-section of the Lower Rhenish-Westphalian group of the Association of German Iron-foundries. Its headquarters are at Cologne, and its operations cover all the occupied part of the Rhineland north of the Moselle and Lahn.

AN ANCIENT TIN MINE.—The Ding Dong tin Mine, near Penzance, reputed to be the world's most ancient tin mine, has been sold, and is to be reopened shortly. The mine is stated to have been intermittently worked since the time of the Phœnicians, over 2,000 years ago. Its longest period of working is about two hundred years, and it was only closed down in the early part of the war.

Steel Turnings for Blast Furnaces.

In a recent issue of "Engineering" there appears a translation of an article by Mr. Tripier, a French metallurgist, in the Comptes Rendus de la Société de l'Industrie Minérale, who remarks that the war has furnished an occasion for the systematic utilisation on a large scale in the blast furnace of steel scrap and steel turnings.

At the commencement of 1915, an ironworks in the North of France lacked further supplies of Spanish ores for the manufacture of hematite pig-iron; the temporary loss of the Briey basin also cut off the usual supply of the best grade of ironstone hitherto available for the making of basic pig-iron. In these circumstances the works were asked to utilise steel turnings in the blast furnace, since these were being obtained in very large quantities in the munitions factories and were not being diverted to a corresponding extent to the steelworks for remelting.

At first, there was added to the burden of one furnace in blast at the time, 1915, and producing hematite pig-iron, a proportion of steel turnings of barely 10 per cent. of the weight of the pig-iron produced. But owing to the large proportion of purple ore briquettes, high in sulphur, also used, the results in the beginning were not very satisfactory, and generally when the working of the furnace became irregular, the addition of steel turnings was stopped. On re-starting, however, the tendency each time was to increase the proportion of steel turnings added to the burden, and after a short while an attempt, which proved successful, was made not to eliminate the turnings in the event of irregular working. In the commencement of 1916 four furnaces were put in blast, and in each of these the proportion of turnings utilised was raised to 20 per cent., 30 per cent. and 50 per cent. of the weight of pig-iron produced. Then the supply of ironstone failed completely for a time and an attempt was made to use turnings exclusively; this was quite successful. In 1917 the works had at their disposal a very large quantity of turnings, and with three furnaces, two hematite and one basic, they had during three months a perfectly regular working, each blast furnace producing double the quantity of pig-iron which would have been obtained with good ironstone. The monthly consumption of turnings exceeded 25,000 tons for the three furnaces.

The works in question being remarkably close to the front, there were frequent stoppages due to bombardment, to damage to the water, gas or blast pipes, or to the blowing engines. Stoppages of several hours, even when they occurred frequently, did not give rise to any appreciable irregularity in the working, whilst stoppages of several days sometimes caused scaffoldings or blocking of the hearth, but such accidents were less frequent and more easily remedied than those which would have occurred in similar circumstances using excellent ironstone. These results are attributed, in part, to the practice of leaving the throat of the furnace at a standstill in communication with the gas from the other furnaces in activity, however long the period of standstill, by which means matters are greatly simplified; it is only necessary to cut off the blast from the furnace in question and to close all communication between the tuyeres and the blast pipe. The furnace thus at a standstill cools rather rapidly, for the slow consumption of the coke it contains does not keep up the temperature. For re-starting it suffices to blow with hot air blast from the Cowper stoves, these being previously heated. It happened once, however, that the above precaution could not be taken, nor could the furnace be carefully damped down, the cause of the stoppage being an accident to the lift;

when the furnace was restarted without any preliminary preparation, after a period of inactivity of eight days, a serious scaffolding was detected. Soundings showed that thick layers had been formed in the belly of the furnace and especially in the shaft, up to 60 in. in thickness and consisting exclusively of red-hot turnings mixed with dust and coke ash. The masses were brought down by a few charges of dynamite and 24 hours afterwards the furnace worked normally. Very high proportions of turnings have also been used in the firing-up charges of blast furnaces, and the starting of the furnaces so charged has been remarkably easy. The furnace walls are not affected by the use of turnings in large quantities, as has been evidenced in the case both of new blast furnaces and of others whose previous period of activity had been more or less long.

The following are some of the burdens worked to, per metric ton of pig-iron produced:—

1.—Hematite Foundry Pig-Iron.

Si., 2.50; Mn., 1.00; S., 0.04; P., 0.08

	kg.
Coke	1,275
Spanish ore	2,200
Limestone	900
Coke	1,300
Purple ore briquettes	1,400
Tap cinder	100
Spanish ore	600
Mn. ore	6
Limestone	300
Coke	575
Turnings	1,000
Tap cinder	100
Ferro-Mn. slag	40
Silex stones	20

2.—Spiegel Iron.

Si., 0.7; Mn., 12.00; S., 0.02; P., 0.1; C., 4.4.

	kg.
Coke	1,275
Purple ore briquettes	1,400
Mill scale	150
Spanish ore	350
Mn. ore	350
Limestone	750
Coke	725
Turnings	900
Mn. ore	275
Limestone	200

3.—Basic Pig-Iron.

Si., 0.3; Mn., 1.25; S., 0.08; P., 2.10.

	kg.
Coke	1,250
Normandy ore	2,200
Mn. ore	70
Basic slag	80
Limestone	1,100
Coke	1,075
Briey ore	1,800
Normandy ore	800
Mn. ore	60
Basic slag	60
Limestone	150
Coke	450
Turnings	950
Normandy ore	150
Basic slag	260
Mn. ore	20

The latter burden showed a loss in the slag of P and Mn. rather above normal. The burden containing a large proportion of purple-ore briquettes for the production of hematite pig-iron, and that containing solely Normandy ore for the production of basic pig-iron, occasionally led to difficulty in the working; all the others worked smoothly. The author gives the analysis of the materials forming the various charges.

From the commercial point of view, he states the following: Above are given two instances of basis pig-iron production, in one of which the coke consumption is 1,250 kg. per metric ton of pig-iron, and in the other 450 kg. per metric ton. In the latter case, using steel turnings, the normal production of a blast furnace burning 200 tons of coke per day is 445 tons of pig-iron, and in the former case the production of pig-iron is 160 tons. It can, therefore, be advantageous to utilise turnings in blast-furnace practice even if the cost price of a ton of pig-iron produced be not decreased by their utilisation.

After additional data on the working of the blast furnaces in different circumstances, for example, with charges containing 95 per cent. of turnings, then changing over to burdens formed exclusively of iron-stone, Mr. Tripier adds that the abundance of steel turnings during the war led to attempts being made to turn this waste produce to account. The cupola, probably, has not yielded good results, whilst the electric furnace entails a high consumption of current per ton of output and a correspondingly large coal consumption if the current is generated in a steam-driven power station. He makes reservations in regard to the prevailing opinion according to which steel turnings find their real scope for utilisation in the open-hearth furnace. Steel turnings, he adds, are a material long and difficult to charge through the door of the open-hearth furnace. Once in the furnace the mass of turnings sinks down and being no further penetrated by the gases it is badly heated up. Working suffers thereby, the furnace has a low heat efficiency and the output is lowered. For a satisfactory use in the open-hearth furnace, the turnings have to be bundled or briquetted. Bundles of turnings are not sufficiently dense for exclusive use in the charging of an open-hearth furnace; a certain proportion only can be charged and they are less expensive to make than briquettes of turnings. Both the bundling and the briquetting plants, however, are costly to put down, and costly also from the point of view of labour and maintenance. Comparative figures are quoted of the cost of utilising the steel turnings in the open-hearth furnace, and in the Bessemer or basic converted, via the blast furnace, and the author concludes as follows: In the case of an ironworks owning all the necessary plant and having turnings, also cast-iron and steel scrap to be disposed of, the question to be decided refers to the apparatus in which this waste should be treated by preference, the choice lying between the blast furnace, cupola, open-hearth furnace, Bessemer converter, basic converter, and electric furnace. A large portion should be set apart for treatment in the blast furnace.

HOME-GROWN v. FOREIGN TIMBER.—At the recent meeting of the Council of the English Forestry Association, Mr. Reginald Brown, representing the Housing and Building Material Department of the Ministry of Health, said that the use of home-grown timber would depend on quality, quantity, and price. Its high quality, soft and hard woods, is admitted. The reference, however, to seasoning in the report presented at the recent Edinburgh meeting of the Landowners' Co-operative Forestry Society, suggests that some detail in the treatment of imported timber may still be a point in favour of the foreign timber. As regards quantity, much home-grown wood will shortly be on the market, as much standing timber purchased by the Government is being sold for general use. Prices in the past had to be kept down in order to ensure the sale of home-grown wood in competition with foreign timbers of equal, if not inferior, quality.

Castings Used in Ship Construction.

PROPELLER-SHAFT BRACKET.—No. III. THE PATTERNMAKING.

By Ben Shaw and James Edgar.

The shaft bracket shown in Figs. 1 and 2 is altogether different in design from those we have already described. Instead of palms or flanges the casting is usually supported by the stern frame casting and the shell plates. It will be noticed, also, that instead of two separate castings, the bosses, the two arms, and the middle table-piece comprise one large casting. This is a form of bracket more common on small or medium size than on large vessels, although the same design is equally applicable to very large ships, but in this case the casting is often difficult and clumsy. If for large work, the centre piece is split on the centre line, each boss and arm being separate castings and afterwards bolted together.

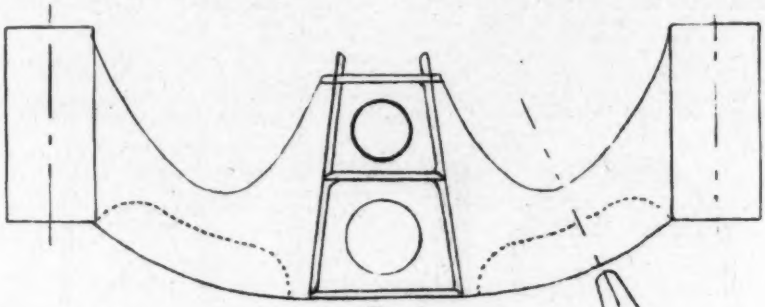


Fig. 1.

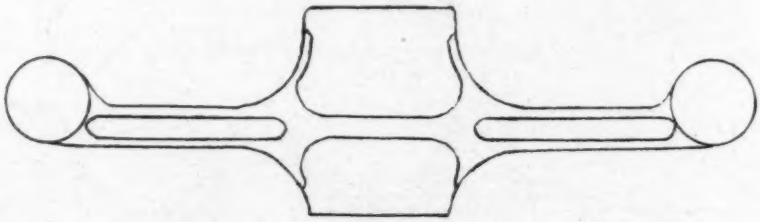


Fig. 2.

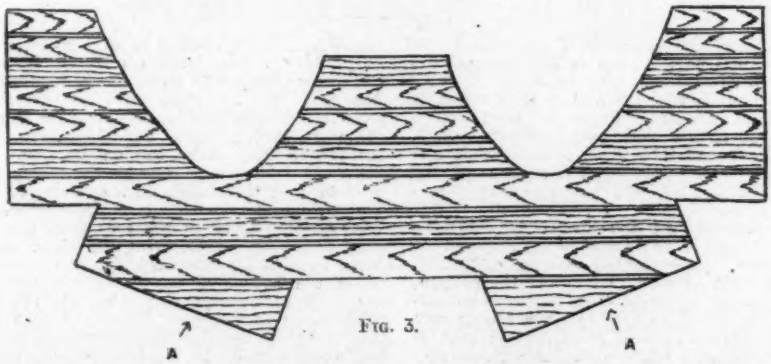


Fig. 3.

The construction of the job differs very materially from the palm type of bracket. It might be possible to make a shell pattern of it, but it would not be profitable. It would take longer time to build the curved ribs which enclose the centre spaces, and which would have to be left loose, than to cut the large fillet on the outside from solid timber and make core-boxes. It would also take longer to build the arms so that the moulder could make a core from them, than it would to make them solid with a print, and use a box. This would not be the case with some work of a similar type, but here the section of arm cores is uniform in its entire length. As to the relative quantity of timber which would be used by each

method—and as it cannot be too often said, this is important—there would probably be more timber used for a shell pattern, because much would be cut to waste and the core-boxes can be made so that little timber will be wanted for them. What, however, should weigh more than either the labour cost or timber, will be the quality of pattern which would be turned out by each method, and certainly the solid pattern gains here. In a shell pattern the heavy bosses would not be properly supported by the narrow arm end, and there would be a grave danger of their breaking. Even if this did not occur the pattern might become warped in the sand, with the consequent result of an inaccurate casting. In this article, therefore, we shall confine ourselves to the solid pattern and core-boxes.

The cores through the bosses are not shown in Figs. 1 and 2, because they are similar to those already dealt with, and the same methods of making the cores would be adopted Several templates would be supplied for this job, for the arms, and also for defining the shape of the centre; but the important template for the pattern-maker would be one giving the contour of the bracket corresponding to Fig. 1. In all probability it would be the same as the drawing, but it might have been modified, and, as usual, it would be from the templates that the pattern sizes would be taken The large template would be placed on a drawing-board or on the floor and scribered round. The contraction would then have to be added, and it might be advisable to set down a section of the arm on top of this plan, and also one or two sections across the centre table.

It is more convenient for the moulder to make the pattern in two halves, the joint being through the centre of the arms. It is essential that the whole pattern should be built on joint plates, and the pattern-maker has to decide on one of three methods—a half-lapped frame may be made, one-thickness boards may be laid edge to edge, and hard wood battens inset to bind them together, or a plate in two thicknesses may be built. The obvious disadvantage of the half-lapped frame is the difficulty of securing strength owing to the irregular shape, as it is not possible to get nails from end to end. The two-thickness plate is not commendable since it is bad practice, as a rule, to have side grain and end grain on one perpendicular, as the side grain shrinks and the result is unsightly and troublesome in the foundry. In the present case, however, strength is the important quality required in the frame, as on it depends altogether the rigidity of the pattern. Fig. 3 is a sketch of this plate. The timber ought to be kept the full width of the boards and left with open joints. The sketch shows the face of the plate with the timber the full width. The other thickness would, of course, be screwed across. When the plates are both screwed, they may be nailed together temporarily, dowelled, and the shape set out and cut. The main centre-line and the boss centres should be squared over on both sides of the plates. The parts of the plates AA, Fig. 3, which support the prints should be wide to balance the cores. It will be necessary to trim off the ends of the plates, after the lagged barrel-pieces have been screwed to the plates, because the centres of the bosses are not on the same plane, as the pattern joint. If, however, the plate is made to the finished length, it is wise to make a large part of the barrel square from the centre line, as shown in Fig. 4, and the small portion full to size at the outside edge so that they can be trimmed. It may be possible for pattern-makers to work so accurately that no trimming off conterminous edges is necessary, but it is safer to leave a little for final finishing. The large portion of barrel is made like an ordinary full barrel with checked stays and lagging. But the small part can be planed from solid timber, or if it is rather large for this it may be made of end grounds as illustrated, with pieces screwed to them, and a stay on the face. The lagged parts can be screwed through the plate, dogs being used to hold them while turning over, or better still the screwing can be done from underneath.

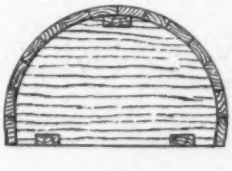


Fig. 4.—End View of Boss.

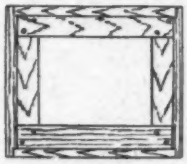


Fig. 5.

Fig. 7.—End View of Arm.

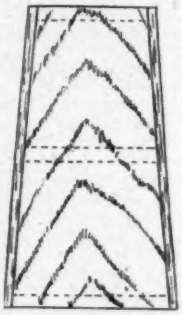


Fig. 6.

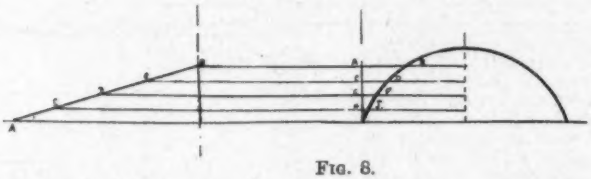


Fig. 8.

Fig. 9.

It would not be practical to construct the centre piece and both arm-fillets as one piece. It has to be borne in mind that the deep side of the pattern would be in the bottom of the mould, therefore the print would have to be on this side. On the top part a print would be dispensed with. The cores would be steady without one because of the large bearing which the circular holes in the centre plate afford. The best way of constructing the centre is to make a box like Figs. 5 and 6. This box would be made the full width of the bracket in length, and across it would follow the inside of the line of metal. Thus the small portions of the cross ribs which are carried to the outside of the metal could be nailed on afterwards, or, better still, wired on so that the moulder could leave this in the sand till after he has drawn the main pattern.

The grounds for the box could be half-lapped frames about 4 in. wide and 2 in. thick, the check being cut from the end rails so that a panel can be screwed in and fill up the space. Fig. 5 illustrates what is meant. Similar boxes are necessary for the top and the bottom.

If the work is very small, the blocks for the arms would probably be made from solid timber or thicknesses glued together, but if of any size, both because of the weight and because of the timber saving, to do other than make them from solid timber joined edge to edge, although most of the segments could be lightened before being built.

The arms built as in Figs. 7 and 8 consist of two grounds and a circular segmental portion on which a top plate or plates would be screwed. The top plate would project a considerable distance beyond the ground at the barrel end, and the fitting shape should be cut so that when the arm blocks are laid on the joint plates no chalking and fitting will be necessary.

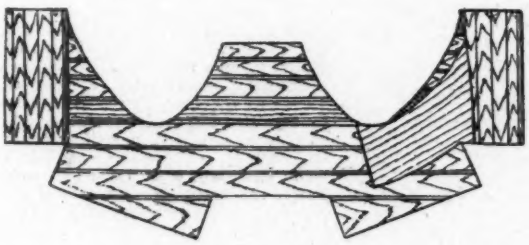


Fig. 10.

Fig. 12.

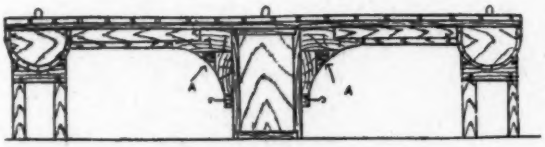


Fig. 11.

Fig. 13.

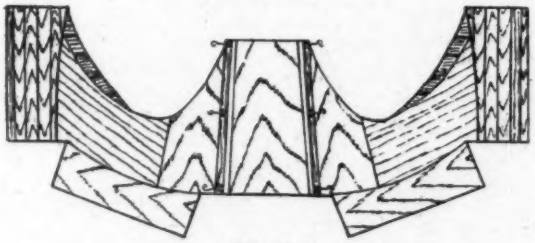


Fig. 14.

Fig. 16.

Fig. 15.

Fig. 17.

and also because built work naturally does not warp like solid work, they would be constructed in a similar fashion to the sketch Fig. 7, where a block is shown sitting on the joint plate. Of course, the print has to be built separately. It should be noted that in the present design the angle of the arms is uniform from the end of the large fillet which connects them to the table centre till they join the boss. This leaves a piece of the joint plate uncovered, forming what is equivalent to a rib to the face of the boss. More often, however, the angle would be lengthened so that the shape of the arm would be different all the way, in which case it would be practically impossible to do other than make them from solid timber joined edge to edge, although most of the segments could be lightened before being built.

This is a matter of simple geometry. Two views shown at Figs. 8 and 9 have to be set down on the drawing board. The line AB, Fig. 8, corresponds to the angle of the arm joining the barrel. Three or four lines would be projected to the front elevation, and the distance AB, CD and EF and HJ would be the distance BCDE, would be carried beyond A. Fig. 10 is a plan showing both barrels and one of the arms fixed on the joint plate.

Making the fillets is rather a big job. If large, they would be built like Figs. 12 and 13, and if smaller they would be glued up solid as shown at A, Fig. 11. Whichever method is adopted before they

are cut to shape, the blocks ought to be fitted into their correct positions, when lines can be drawn off the arms. Of course, it is not possible to build that part of the fillet beyond the arm proper, which is shown in Fig. 12.

Fig. 12.

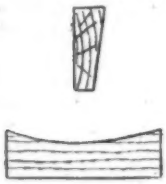


Fig. 19.

Fig. 20.—End Elevation

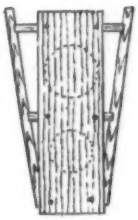


Fig. 21.—Plan.

Fig. 22.
Section of Top Core.

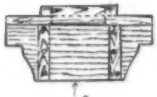


Fig. 24.
Elevation of Top Core.

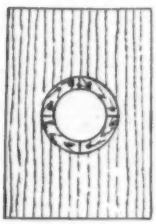
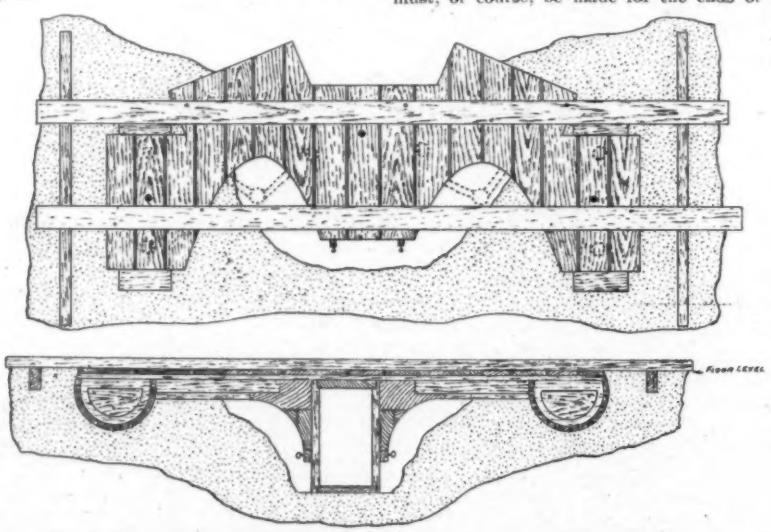


Fig. 23.
Plan of Top Core.

The prints for the arms would be made solid or boxed up according to the thickness. As a general rule, although it is not so hard and fast when work is less than 3 in. thick, it is well to box it up. If these prints were made in this way, an inch plate would be for the top with a front of the same thickness and two thicker ends. It is always good practice to make the grounds much thicker than lagging or staves, because they have to take screws and also because they are more rigid and stable. The ends would be checked into the sides; that is, the sides would be recessed to form a shoulder, which would prevent any likelihood of the ends being knocked in.

The pattern would now be ready for turning upside down to build the other half on top. It is not essential to build the one half on top of the other, and if sufficient men are available the two halves could be progressing concurrently, as long as the joint plates are made together. It is always necessary, however, to try the two halves together before the pattern goes to the moulder, so that faces can be tested with a straightedge. There is also less danger of details being forgotten, when the whole work is seen together. Before the half pattern is turned over, however, some supports are necessary to carry the barrels, as shown in Fig. 11. Accuracy is necessary for these supports as the joint plates must be kept quite straight while the second half is being built. If the pattern is built with a twist it is well nigh impossible to rectify it after it is finished. To safeguard against this when building such a large pattern, the joint face of the completed portion should be sighted with parallel straightedges, or winding strips as they are usually called.

It is not necessary to say much about the second half as, apart from its being shallower it is similar to that already described (as no print is needed). The centre box for this half is made to the top of the ribs. The ribs at the end of the centre table can now be screwed on. As it is possible that the moulder will leave them in the sand when he draws the pattern, no driving nails should be used to fasten them. Although they are not shown in the plan of the finished pattern, Fig. 14, or in the front elevation, Fig. 15, prints must, of course, be made for the ends of the barrels



Figs. 25 and 26.—Showing Plan and Elevation of Bedding-in-Method.

One half of the pattern would now be nearing completion. The ribs that project beyond the ends of the centre box are best left till the two halves are together to ensure their being in line top and bottom.

As a guide for the moulder in the shallow half of the pattern the central block should be painted black or such a colour as the prints are painted to signify that the core is to the outside. Much time is

wasted in the foundry measuring core-boxes to get thicknesses, which ought to be given by the pattern-maker.

The easiest method of keeping the half pattern rigid while being conveyed to the foundry, is to make two long bars about 8 or 9 in. wide and 3 in. thick, and screw them to the joint plates. In all probability the moulder will leave them on the pattern while moulding the bottom half.

The core-boxes are not difficult to make. They are four in number, one being necessary for the arm, and three for the table. For the arm core a half box is all that is required. Fig. 16 is a plan of it. When the bottom plate has been made, a thickness of timber at least ½ in. more than half the thickness of the print would be screwed to it, and cut to the contour of the core. If the box was made just the half core depth, on the piece like Figs. 17 and 18, there would be a feather edge. The taper of this piece should be planed while the timber is rectangular and the core shape afterwards drawn on it. A piece like Fig. 19 and ½ in. thick has now to be fitted, and completes the box. In the foundry two half cores are made and glued together afterwards.

The table core is best made in three boxes. If it were made as one core in a box it would be a difficult core to make, and it would be delicate for handling afterwards. It is really simpler in both patternshop and foundry to make the portions of the core above and below the middle plate separately, connecting them by means of a socket joint, formed by placing prints in the core-boxes which is for the moulders' bottom core, projecting circular cores being made on the top boxes. While the whole of the bottom core, the core that is with the main print is undivided, the top core must be in two as there is no print and there is a middle dividing rib. The two cores might, of course, be made in one box, but it would be inconvenient in the foundry, and the little extra labour involved in the patternshop in making two boxes is well worth while. By glancing at Fig. 20 to Fig. 24 it will be noted that the construction of the top and bottom boxes is different. Boxes are not always made in the patternshop with a thought to the moulder getting his lifters in and making the most suitable grids, but they ought to be, with some exceptions of course, and these boxes are designed with this object in view. The one style of box is as cheap as the other.

The bottom box consists of two sides and two ends, the ends being let into the sides. The sides are carried up to the beginning of the curve. It is not necessary to have a bottom on this box.

On the top and resting on the ends is a bar to carry the print. This bar ought to be dowelled so that it can be replaced without any trouble. There is a little more work making the other boxes. Bottoms are necessary, and the circular holes have to be cut through these bottoms. The reason for placing rings of segments on the underside of the plates is to save timber and make the boxes lighter. Blocks (A Fig. 22) must be made and screwed to the bottom. They ought to make the core to the centre of the radius, and beyond this can be strickled in the same way, as the major part of the bottom core would have to be strickled off. The ends of the box (B Fig. 24) are made sufficiently long to enable them to be screwed to the ends. In all these boxes it is advisable to batten the ends, and it may be necessary to fit brackets against them to prevent their being rammed outwards.

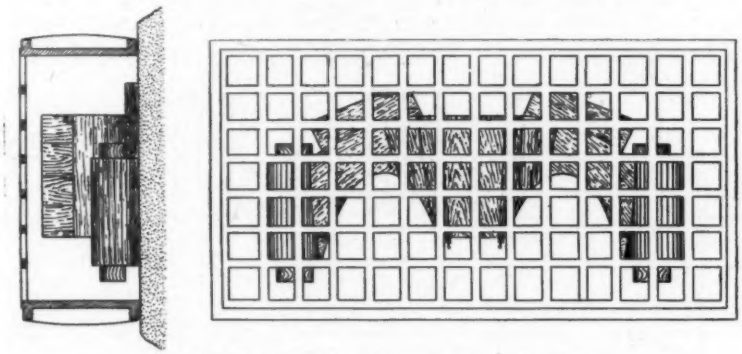


FIG. 27.—SHOWING ONE FORM OF SOLID DRAG BOX.

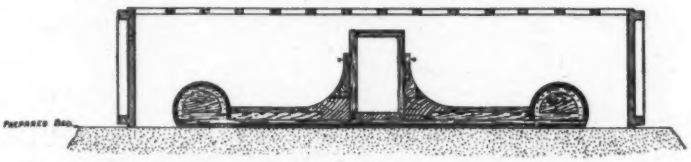


FIG 28.—DRAG BOX SET PREPARATORY TO RAMMING.

Moulding the Bracket.

The type of propeller-shaft bracket under consideration gives better opportunities to the designer in devising a support for the shafts, which, while possessing the requisite strength, will also assist materially in reducing casting difficulties in the foundry. In this instance, the sweep of the arms connecting the bosses with the centre piece illustrates an exceedingly good design from the foundryman's point of view. The heavy metal is sweetened off gradually, and there are no abrupt connections, hence, whichever way the work may be cast, it will make little or no difference, as only ordinary precautions need be taken for contraction, it being unnecessary to consider the possibility of a rupture with such a design. But, though the contraction difficulties are considerably lessened, the method of running the casting, and bringing off suitable risers must be given special consideration to eliminate the formation of porous metal at the junction of the arms with the bosses and centre piece.

Many foundries are governed by particular methods for want of suitable tackle. The practice of bedding in practically all work outside the capacity of their stock of moulding boxes is that prevailing with so many foundries, and is frequently the cause of wasters. Such methods are usually adopted to reduce the cost of production, but in the long run they are far from being economical. Such a method would be adopted in this instance by many foundries probably owing to the depth of drag box required, or may be through lack of crane capacity in making the required lift. If, however, the tackle is available, or it can be built up from stock, with additional parts made to suit, it would be preferable to make the mould in such a way, as to allow it to be cast with the bosses in a vertical direction. When no large drag box is available, and it is considered desirable to make a special box, then bedding-in must be resorted to. With a large pattern of this design this is a long and tedious job. A level bed should be prepared, the logs being set far enough apart to allow the intervening space to accommodate the pattern, since the straight-edged logs have to be left in the sand until the pattern is bedded in position. The smallest, or top part of the pattern, can be laid upon the bed, and a rough outline made to form a guide in removing surplus sand. The approximate shape of the joint, joining the surface with a good taper, as shown in Fig. 26.

The logs can be removed and the joint made up for the cope box. Moulding such a bracket in this way offers poor facilities for bringing off suitable risers. It can be cast satisfactorily from gates set at the back of the arms, the approximate position being shown in Fig. 25, but it is a most difficult matter to fix risers, so that metal can be fed to the thicker parts, and especially to the thick divisional plate of metal, between the central cores. Two or three risers are usually brought off along the highest part of the bosses, and a good riser is brought off at an angle from each side of the centre piece and at the thickest part of the fillet, as shown in Figs. 25 and 26. When a drag box large enough to take the mould is available, and it takes the form of a solid box, as shown in Fig. 27, the roll-over process can be resorted to, and greater satisfaction will result, because of the better facilities for ramming. The prepared bed on the foundry floor is equally necessary in this instance, and the bottom portion of the pattern is laid on in an upside down position, as shown in Fig. 28.

When this type of drag box is used, a considerable number of grids are required to give additional support to the sand, and they should be secured to the

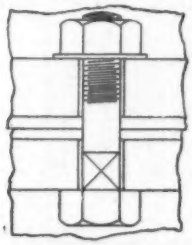


Fig. 30.

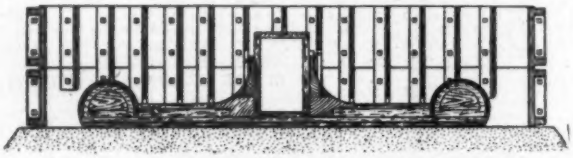


Fig. 29.—Section of Built-up Drag Box in Position on Prepared Bed.

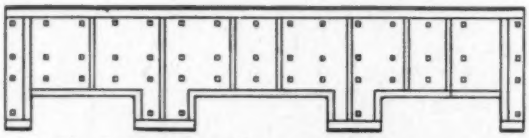


Fig. 31.—Loose Side on Drag with Runner and Riser Clearances for Casting Sideways.

centre piece can be removed, and the bed made by using a depth gauge from the surface. With this centre bed made up, and a considerable amount of the floor sand removed to allow the pattern being lowered into position, and providing battens are secured to the joint of the pattern, as indicated in Fig. 25, the final position will be secured, when the battens rest upon the logs, and the centre piece rests upon the prepared bed. It is advantageous to have a special support for the centre piece, in order to ensure its going down far enough without sagging, so that when the battens are removed, the joint of the pattern is flush with the surface bed. With the floor sand well clear of the other parts of the pattern, and access made to the small loose pieces, representing the continuation of the ribs in the centre piece, the process of ramming in the special composition facing can proceed. The sand requires to be tucked under and rammed sideways, necessitating very awkward working positions for the moulder. Owing to the possibility of lifting the pattern while ramming in this way, it is customary to lower weights upon it as soon as sufficient support is given to the pattern to sustain them. When the joint of the pattern is reached, it should be compared with the originally prepared bed, to make sure that no change has taken place. The joint of the mould is similar to the joint of the pattern, excepting at the outside of the bosses. At these places the sand requires to be cut out, and a short bed made from the outside part of the boss, and parallel with the main drag box in such a way as to prevent any possible risk of a fall when the box is rolled over. In some instances boxes of this character have a series of holes cast in the sides, to enable the moulder to bolt in straight bars, just over the pattern, and deep enough to give rigidity to, and act as a support, for other grids to which they can be secured. Only a few such bars are necessary, and they need to be fixed in the box when it is lifted, and after their positions have been located, convenient sized grids can be laid along the bars temporarily, so that they can be moved to their final position and secured when composition has been applied, and a certain amount of ramming done. When the whole box is rammed up, it is rolled upside down, and the joint of the mould made up, similar to that already explained, and a commencement made with the cope. In this method, unless the drag and cope boxes are specially cut away to permit of casting the job on its side, the metal would be poured in much the same way as in the previous instance, the advantage of using such a box being that gained through consolidating the sand to a more equal density.

Another form of drag box, which is gradually being recognised as possessing many advantages for work of this kind, is the built-up box, sides and ends being bolted together, and ordinary box bars bolted in between the sides. Stock bars used as far as possible, additional ones being made to follow the contour of the pattern. Owing to the depth of the drag re-

quired, it may be necessary to use two sides from stock, to get the necessary depth as indicated in Fig. 29. Stocks built up of standard types having slot holes for bolts set at standard centres, similar to some of the more modern foundries, fulfil such requirements. A plan and elevation of a connecting bolt is shown in Fig. 30, and if the slots are made a fixed distance apart, say 6 in., as many may be used as necessary to meet requirements, furthermore, guide pins can be bolted to the joint flanges, when both drag and cope boxes are rammed up, and before they are separated.

With built-up boxes of this character special sides for casting work, either sideways or endways are usually available, but suitable parts can be made for any individual job, and no more time would be lost than is occupied in preparing proper tackle when a solid box is available, the advantage being that new sides or bars would increase the stock and be useful in any future work of a similar character. Such a box side is shown in Fig. 31.

The roll-over process is adopted with a box of this kind, the pattern being laid upon a prepared bed, and the box set in an upside down position over it. The box-bars, which should be a little less in length than the inside size of the box, can be lowered into position and bolted up. In no place should these bars be less than 1 in. from the pattern. Providing the bars follow the contour of the pattern fairly regularly, no additional support for the sand is necessary, but this is only likely to apply, when all are specially made for the job. When they are drawn from stock, gaggers would be used to support the sand, and make up for any deficiencies in the bars. When the drag has been rammed it can be rolled over, a proceeding necessitating care in lifting with the crane, owing to the built-up nature of the box. When this is satisfactorily accomplished the joint can be prepared as previously indicated, and shown in Fig. 32. This method gives the advantage of casting the job on its side, and enables the foundryman to bring off more suitable risers, and likely to ensure a sounder casting, then in casting flat. Casting with the bosses in a vertical direction, the metal can be supplied by means of sprays to each of the bosses, and because of the assistance given by the sweep of the arms, the highest points should be the faces of the bosses; then risers can be formed on the surface of each boss, near the junction with the arms, and also from the thick plate between the two cores of the centre piece. Allowance should be made for these before the cope box is set in position, by bedding in gate sticks to come through the side of the box. With this arrangement made and the cope box lowered into position, box bars can be fitted in similar to those for the drag, as shown in Fig. 32, gaggers being used to strengthen and support any parts requiring additional supports, such as the lift at the sides of the bosses. The ramming up of the cope is a straightforward job, a good supply of compo being required before being backed up with the floor sand. Before the boxes are separated the precaution must be taken to attach suitable grids, so that there will be no difficulty in replacing the cope in its true relative position with the drag.

With the exception of a few small subsidiary portions representing rib extensions, each part of the pattern can be withdrawn with one lift, and the process of sleeking both drag and cope can be done simultaneously, and to give a good solid surface, such as is required in work of this kind, the moulder should be unsparing with nails. The joint corner should be depressed, as also should the junction of the core prints with the mould, to prevent any likelihood of crushing. Sharp corners of sand should be rounded off, unless they are specially required to be sharp, and to prevent the sand, giving way before the inrush and pressure of the molten metal, all sharp corners should be well nailed. Both drag and cope should be transferred to an oven to be dried, if facilities are available for stoving, otherwise both parts will need to be dried by suspending or supporting the cope over the drag, and using patent driers, or coke fires, localising the heat by surrounding the boxes with sheet iron, or by whatever means are available.

While the preparation of the mould is proceeding, the cores will receive attention to expedite the completion of the job. The shaft cores are usually made straight, and are most conveniently made on perforated spindles, as the length of prints can be extended to accommodate suitable spindles stocked. Special attention must be given to the composition used on these cores, since the spray runners cause the metal to impinge upon them, when the job is being cast. The mixture must

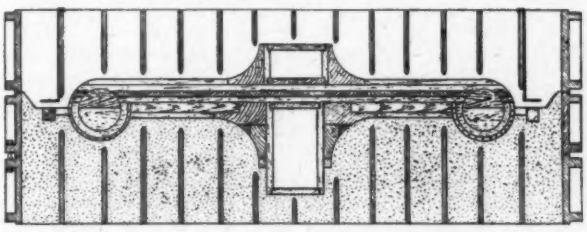


FIG. 32.—SECTION SHOWING JOINT FORMED AND DRAG BOX IN POSITION.

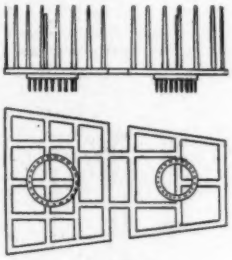


FIG. 34.
GRID FOR TOP PART OF CENTRE CORE-PIECE.

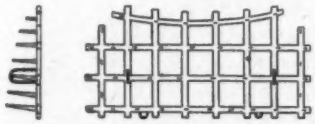


FIG. 33.—GRID FOR ARM CORES.

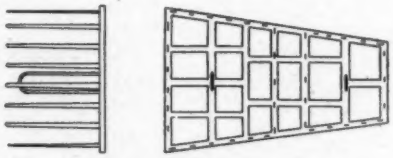


FIG. 35.
GRID FOR BOTTOM PART OR CENTRE CORE PIECE.

be strong and of a highly refractory nature. The arm cores require grids, a suitable form being shown in Fig. 33. It will be noticed that besides the ordinary lifting staples, two smaller staples are cast on the print side of the grid, these facilitate the fastening back of the cores, when they are finally placed in the mould, and obviate the element of risk, which would be present if the mould should be cast without any security against the cores lifting. Corner pieces can be set in the core box, both top and bottom, to give a guide for the amount of corner required to be removed, to give the necessary shape to the cores. This can be done when the core is sufficiently stiff to allow its being stripped. The largest of the centre cores should be made with its print side on a plate, composition being laid upon it, and a grid, as shown in Fig. 34, joining the two sections and pieces notched out to allow it to be set back into its right position. The formation of the core is then proceeded with in a similar manner as for the larger core. When all the cores are stripped, corners removed and sleeked over, they are conveyed to a drying oven. Runner and riser basins require to be prepared and dried, the risers being given substantial heads.

When the moulds and cores are dried, and any cracks formed properly filled in, the whole should be painted and again thoroughly dried. Owing to the heavy nature of castings of this type, instead of painting a mould and cores with a liquid solution of the composition, as is usually done for castings of smaller sections, the application of tar gives better results, and such a covering should be given in this instance

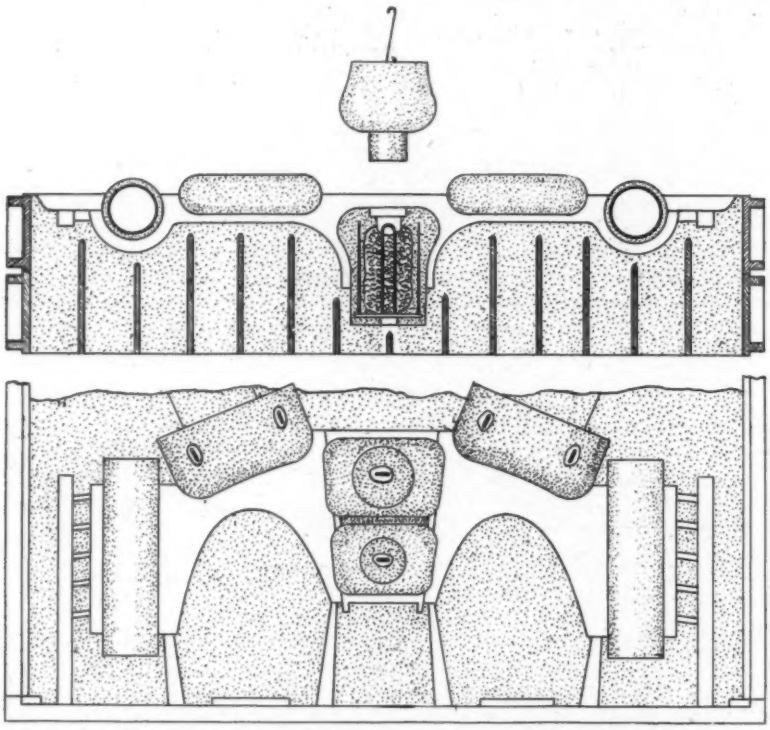


FIG. 36.—PLAN AND STRUCTURAL ELEVATION OF DRAG IN PROCESS OF CASTING

bedded in, and then the core-box planted over the top. The batten carrying the core prints for the lightening holes in the central plate being dowelled, can be removed while the core is being filled. A shell of about 3 in. to 3½ in. of composition should form this core, the inside being fitted with ashes and rammed. The lifting staples require to be placed about the centre line of the lightening holes. In filling boxes, requiring to be strickled, it is better to have the composite projecting until it is stiffened, the strickling being done just before the core is stripped. With the smaller or top centre-core the rib cuts it into two. Under such circumstances it is better to form as one core, by carrying the grid through the rib, and having the intervening portion of the grid cast with the job. A convenient form of grid for such a core is shown in Fig. 35. Two loose rings are made, and secured to the main grid as shown. When filling this box the central rib is removed, enough composite put on the box to form a bed for the grid, which is then lowered in, the rib is replaced to get the position of grid to ensure a better skin on the casting. The runner basins should be treated in a like manner.

With the mould, cores and runner and riser basins thoroughly dried, a beginning can be made to close the job. It is desirable to have everything ready so that no time is wasted from the beginning of closing until the metal is poured, so that the mould receives the metal while it is fairly hot, as other things being equal, a better casting is obtained that when the metal is poured into a cold mould. A vent hole can be made through the drag cope, so that pipes may carry air and gases from the centre core at each side. The bottom centre-core is lowered in, the staples cleared to connect the vent with the top core, which should be lowered into position and the total height tested. A small amount of clay, surrounding the junction of the vent holes, over which oil is poured, is a good precaution against the metal finding entrance to the core vents. The two cores should be secured, hook bolts attached to the bottom staples, and passed through a plate resting on the grid of the top core, and then

screwed up, will serve the purpose. Some moulders prefer securing the top core in the cope before turning it over, but whichever method is preferred, care must be exercised to prevent crushing. At the top of the centre core, a part between the ribs serves as a print, and to assist in a safe closing, this part in the core should be tapered well back. The arm cores and shaft cores can be set, the former can be secured to stakes by hook irons, as shown in Fig. 36. The latter offers no special difficulty, being merely laid into the prints, and the ends of the cores tapered back. Make sure that the runners and risers are clear, and their junction with the mould rounded over. The illustration, Fig. 36, shows the drag with the boss, arm, and bottom centre cores in position, and the top core ready for lowering. When all the cores are placed, the cover boxes are turned over and lowered into position, having previously set pieces of clay on the top core. The cope should be lowered very steadily, and its position located as accurately as possible, before the core and its print in the top are likely to come into contact. It is safer to lift again after the top box has been in place, just to make sure that no crushing has taken place. If the centre core is clear of the top, take the precaution of putting clay round the vent, and covering it with oil before finally closing. Bolt and clamp the two parts together, and, if possible, lower the whole into a casting pit, in its casting position, so that sand may be rammed against the sides, and relieve the pressure on the boxes, when the metal is being poured. The gates and risers should be stuffed with sacking while this is being done. When the mould is fixed for casting, the prepared runner and riser basins can be grouted into their respective positions ready to receive the metal.

As in all other instances, castings of this description require to be annealed, so as to remove internal stresses, and to give a finer and more uniform texture to the steel. The annealing furnace should be heated as gradually as possible, so that the casting may be heated uniformly throughout, and the temperature raised to about 800 deg. Cent. While it is important that the temperature should be raised gradually, it is of greater importance that the temperature should be reduced gradually.

Practical Hints for Apprentice Patternmakers.

By James Edgar.

The countersink gouge is more often an evil than a necessity to the patternmaker. It should seldom be used except when driving screws into hard wood.

It is a great mistake to sink screw heads far under the surface of the timber, as the fibre swells over them, and even if they have not to come out immediately, an alteration to the pattern may necessitate their being withdrawn at some future time. In addition, in the case of fragile work, a pressed screw may cause a shake, which, while not noticeable at the time, will ultimately spoil the pattern. The face of the screw head should be just flush with the surface of the wood, and if cheeseheaded screws are used, the whole of the head ought to be above the surface, or the idea of the cheesehead is lost.

The number of workmen who seem to think that the hammer is solely for driving in the screws, and the turnscrew only for taking them out is surprising. The habit of hammering screw heads often causes considerable trouble in the foundry, because of the head breaking in two.

There is a temptation for the patternmaker to use finer screws than he ought to do. In constructing heavy work screws finer than No. 14 are not of much use, and care should be taken in boring the holes to see that they are a tight fit.

When making coreboxes with battened sides and ends, the battens should be cut the full depth of the box, so that any shrinkage which alters the size of the corebox may be detected. This is not of great practical help to the moulder unless the core is in two halves, when the battens in each half meeting will keep the box the correct depth, but it is an indication of whether the core is too large or too small, and very important in the case of thin castings. The workman's objection to doing this is of course the trouble of planing the end grain of the battens, especially if a good trimmer is not at hand. It is, however, really good practice.

There is often a tendency with apprentices, and this is not always confined to apprentices, of using blunt-edge tools and relying upon sandpaper for finishing work. This is a great mistake. Rubbing hollows in work is unavoidable when sandpaper is used to do the work of the tool. The skilled man pares his work so well that it is almost unnecessary to use sandpaper. It is one of the unfortunate results of the introduction of sandpapering machines that lads do not now strive after skill in sharpening and manipulating tools, as they used to do. It is a pity that they are allowed to use machines at all in the early years of apprenticeship. To avoid sharpening, lads often use the wrong tools as with gouges, but it is not possible to pare a large radius well with a small radius gouge.

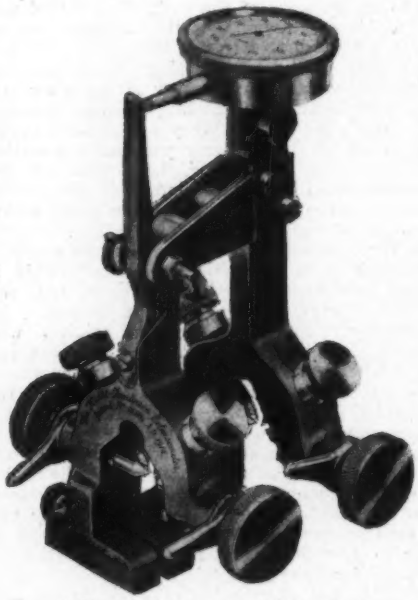
The most valuable advice that can be given to apprentices is to watch the moulders. Skill in setting down work should be striven for, and skill in construction is very important. No opportunity should be lost in talking with moulders about their work, and finding out just how work ought to be made to simplify the moulding. Of course there are many patterns which can be moulded in several ways, and it is not always the best way which is chosen, but the moulder has his own reasons for choosing a certain way, and it is always worth the patternmaker's while to find out what they are. *The really skilled patternmaker is a good moulder.* It is a mistake to suppose that a foundry is a bad place for a patternmaker to serve his apprenticeship. Facilities are not given for learning setting-out or constructing large work; but observation of work that is sent to the foundry compensates for much and one of, if not *the* best, patternmakers that I have ever known was a man who had served his apprenticeship in a general foundry.

CAST-IRON WELDING.—In the course of an article in a recent issue of "The Iron Age," dealing with electric welding of wrought iron and steel, a writer remarks that cast iron, due to its properties, is unsatisfactory for welding by any method. Its low strength and brittleness cause it to break from expansion and contraction strains unless precautions are taken, and even then a successful weld cannot be assured. Pieces of simple cross section and heavy pieces present much less difficulty than complicated shapes, but due to the undependable nature of cast iron, care should be used in all cases. The experience and skill of the operator are large factors in determining whether or not a given weld will be successful.

A New Form of Extensometer.

We have received details of a new form of Extensometer designed by Mr. J. E. Hurst and Mr. G. A. Tomlinson, and manufactured by Chas. W. Cook & Company, Limited, the University Engineering Works, Manchester.

Extensometers have hitherto been seldom used in the routine commercial testing of the properties of metals used in engineering construction, and until recently it has not been considered necessary to include any determination of the elastic limit of the test piece. This practice proved fairly satisfactory so long as the number of different materials in ordinary use was limited to comparatively few whose elastic properties were well understood. Thus, for example, in testing a piece of mild steel, the general type of relation between stress and extension is so well known that sufficient information could be obtained by measuring the ultimate stress, and in some cases perhaps also a rough estimate of the yield point by means of a pair of dividers. Within recent years, however, rapid progress has been made in metallurgy, and many new



THE "HURST-TOMLINSON" EXTENSOMETER.

varieties of special steels and alloys have been introduced which have such valuable properties that they have rapidly come into very general use.

Many of these new materials have to receive special heat-treatment which greatly affects their elastic properties, and it is highly important that every test should include a reliable measurement of the elastic limit. A measurement of the ultimate strength only is inadequate, and any conclusions based on this may be seriously misleading and may result in the breakdown of a number of machine parts if the heat-treatment has not been correctly carried out. The determination of the elastic limit involves the use of an extensometer, and it is very desirable that the type of instrument shall be such that the time required for the test is not unduly increased by including the observation of the elastic limit, and in many cases it is of importance that the instrument can be used by a comparatively unskilled observer.

In the extensometer referred to, the object has been to produce a strong and durable instrument which can be rapidly attached to and detached from the test piece and by which the extension can be measured as simply and directly as the corresponding load. At the same time the degree of sensitivity and accuracy which has been found by experience to be desirable in an extensometer has been maintained, and the instrument is in every respect suitable for use in more detailed tests of materials or in special investigations of the elastic properties.

General Features.

The "Hurst-Tomlinson" Extensometer is adapted for use on a specimen 2 in. in length, as this is the length most frequently employed in commercial testing. It is provided with two forked levers and fitted at the fork with pointed clamping screws which when tightened on the test piece form the pivots of the levers. The dial indicator is attached to one end of the upper lever, and the other end, beyond the test piece, has a stout vertical lug extending downwards from one extremity of the fork nearly to the level of the lower lever. Here the lug bends inwards and one arm of the fork of the lower lever extends inwards in the same way. The two levers are connected by a short length of piano wire which lies in the central vertical plane of the two levers. This forms an elastic hinge so that as the test piece stretches the free ends of the levers open away from one another. This method of connecting the levers also permits the test piece to straighten out slightly under the load, if originally slightly bent, without straining the extensometer. The lower lever is shorter than the upper one and it carries at the free end a short vertical screw with a large milled head The end of the screw is rounded and polished, and bears on the end of the shorter arm of a third lever which is attached by a short length of flexible steel ribbon to a bracket which is screwed and dowelled to the upper main lever. The end of the longer arm of this third lever bears upwards on the end of the plunger of the dial indicator. The system of levers is proportioned so that the movement transmitted to the indicator is ten times the extension of the test piece.

By turning the milled head of the screw, the dial indicator can be brought to zero before the load is applied, a light spring maintains the end of the small lever in contact with the point of the screw. While the extenometer is being attached, it is necessary for the two main levers to be rigidly locked with the axis of the clamping points parallel and at a distance of 2 in. apart. This is accomplished by inserting two locking pins, one of which constrains the axes to be parallel while the other fixes the distance between them. The first pin is placed in the same horizontal plane as the wire hinge and its axis intersects the centre of the wire so that the insertion of this pin leaves the levers only one degree of freedom. The second pin correctly fixes the relative position of the two levers.

In order to ensure that the clamping points shall grip the test piece along a diameter and not along a shorter chord, two screws are placed in the forked part of each lever inclined at about 45 deg. The axes of these screws intersect the axis of the test piece and the ends are rounded to bear at points on the test piece. The usual diameter of the reduced part of the test piece is 0.564 in., which gives a cross section area of $\frac{1}{4}$ sq. in. and the length of the screws is such that when just tight the ends are 0.282 in. away from the vertical plane through the clamping points.

When attaching the extensometer it is simply held up against the test piece bearing on the ends of the four screws and the clamping screws are tightened and the points pierce the test piece along two diameters; it is thus a self contained marking-out jig. As soon as the instrument is fixed to the test piece, the four screws are slightly slackened so that they are just clear while the test is being made.

The Works Manager and His Progress Department.—II*

By William J. Hiscox.

The previous article dealt with the inefficiency of the Progress Department in engineering factories where the importance and the functions of the department were under-rated by the works manager—factories which from a progress point of view may be said to be badly organised. It is not only this type of factory, however, which has the misfortune to possess an inefficient Progress Department, for many of the great engineering concerns, which pride themselves upon their scientific organisation are equally unfortunate. The attitude of the works manager towards the department may (as in the other instances) be said to be at the root of the trouble, although over-anxiety rather than otherwise to secure an efficient department is in this case the weapon to court disaster.

To a manager of this school the importance of the Progress Department cannot be over exaggerated, and the department should be constructed upon scientific lines to ensure its being in a position to discharge its obligations. The department controls the factory; it plans and instructs in all matters appertaining to delivery, and its work in this connection is law. So far so good, but then comes the question of the personnel. The manager recognises that, to ensure the efficient working of the department, the officials must be high-grade men, but what he does not realise is that they must be specially trained men. He classifies the work as technical, but does not estimate correctly the peculiar characteristics of the work, and, a mechanic himself, cannot understand important technical work being undertaken by any but a practical man, i.e., one who has had either machine or bench experience. So he insists upon a personnel of mechanics for his department, and mischief results. It is the lack of appreciation of the training necessary to produce the efficient progress-man which has such a detrimental effect upon the Progress Department, and in the case where mechanical qualifications are the only passport to the department it is obvious that efficiency must suffer. The man from the bench or the machine may develop into a first-rate progress-man, given the opportunity, but that opportunity must come through a form of apprenticeship, where the rudiments of the profession are learned, and where a proper appreciation of the difficulties to be encountered and the duties involved is taught. By all means encourage mechanics to take an interest in progress work, which is an education in itself, but see that they possess the necessary qualifications before offering them positions, the importance of which can scarcely be exaggerated.

The manager who will not admit any but mechanics into his Progress Department is courting trouble, for in emphasising the technical nature of the work he quite overlooks both the necessary commercial and the organising qualifications. The progress-man first and foremost is an organiser, and his ability in this connection is constantly being tested. The manager would probably assert that for the progress-man to efficiently discharge his duties he must be conversant with the method of construction of the line of manufacture he is called upon to control; but this is not altogether correct. Whilst it is essential that the progress-man should understand construction in its broad sense, and know the position occupied by the various component parts on a certain unit, and the sequence in which they are required, it certainly does not follow that he should know precisely how they are fitted, or why they are fitted. The view of the mechanic is obviously narrow, and quite contrary to that of the efficient progress-man, whilst his commercial qualifications are usually deficient.

Another manager must yet be vanquished before we approach the ideal, and this one is so near the top that one naturally hesitates to criticise his attitude. Nevertheless, it is a fact that elaborate organisation is almost as bad as no organisation at all, an inefficient progress department being the result in each case. Two illustrations may be used to show the dangers of an elaborate system, one being the system understood by the Progress Department but by practically no one else in the factory, and the other being the "over-sectionising" of the Progress Department.

To deal with the first, an intricate system is more trouble than it is worth in the average engineering shop. It must be realised that all who work in the factory, from the works manager downwards, are subservient to the factory system as established, and are bound to observe the rules and regulations embodied in that system. Bearing this in mind, it will readily be admitted that, the more simple the system the greater the chances are of its intelligent interpretation, and consequently the higher degree of efficiency attained, and this is particularly the case with regard to the progress system.

The progress system is essentially a workshop system, and must be thoroughly understood by all in the shops, from the foreman to the shop boys. It affects the foreman's procedure, and it consequently affects the operator, and if either of these people have constantly to be educated in order to carry out the demands of that system, then production must suffer. It is the omission of details that adversely affects a Progress Department, for no one seeks to wreck a system by openly defying it.

An intricate system is always causing trouble and creating situations which tend to prevent the harmonious working of the organisation, and when friction is present efficiency suffers. The officials of the Progress Department probably understand the system, but this is not an advantage if they are the only people in the factory who do understand it. Their effectiveness is quite overshadowed by their energy, inasmuch as their work is intensified through having to explain the whys and wherefores of this and that, to pull this man up because he is going too far, and to push this one along because he has not gone far enough. The intricate system is productive of superfluous energy in every direction.

In a well-organised factory, "queries" should not have a place, and yet in a great many apparently well-conducted factories they claim a large amount of attention. It is one thing for a person to understand a system, but it is quite another matter for that person to transmit that knowledge to someone else, and when this procedure has to be carried out throughout the entire factory, confusion and misunderstanding must inevitably arise. A system has for its object the elimination of "waste" time, and this fact must not be lost sight of by the works manager when the system is being framed.

The craze for an elaborate system is made manifest in another direction by the works manager who resorts to "over-sectionising." The trend of modern engineering-shop organisation is towards sectionalisation, whereby the maximum production is attained by the specialist. Thus the machine shop is divided into

* Part I. appeared in our October issue.

the turning section, the milling section, and so on, and each of these sections is in turn sub-divided, so that practically each machine is handled by the man most capable—in fact, by a specialist in the particular class of work involved. This may be the most economical method of production, though whether it be to the advantage of the worker is another matter. The manager referred to applies the same method in connection with his administrative staff, and establishes his rate-fixing, costing, estimating and progress departments. In the broad sense this cannot fail to be successful, seeing that each department deals with a definite part of the works organisation. It is in the sub-division of these departments, however, that great care must be taken, if the object aimed at is to be attained.

The progress-man must retain his individuality if he is to remain efficient, and he must never be allowed to deteriorate into a mere slave of system. He must have a definite duty to perform, and in the performance of that duty he demonstrates the practical value of the system. A well-organised Progress Department does not mean a multiplicity of forms and notes, so intermingled as to result in duplication, as the ultra-sectionising of the department will produce. Reference was made in the previous article to the progress-men who were in reality but records clerks, and it is to be feared that in a large number of factories (where sub-dividing is a fetish) the progress-men are in a like position. Their work is so divided as to make it impossible for them to evince the proper interest, to develop that broad outlook which is so essential to control, and to assume the responsibilities which are vital to the efficiency of the department.

We are now approaching the ideal, using as our next illustration the works manager, who understands and appreciates the value of the Progress Department to such an extent that it is of practical value to him. He may not accurately gauge the full significance of the influence of the progress system, but he does recognise it as the centre of the works organisation, and that as such it must receive official recognition. He looks upon the Progress Department as a business proposition, possessing boundless possibilities, and he is prepared to go to any length in order to make it a Progress Department in fact as well as in name.

In the first place, he knows what progress work is, and what it entails, and he recognises the necessity for highly-trained men to carry out the multifarious duties involved. This fact at once sets the department upon a very high plane, for it is obvious that the foremen and other highly-placed officials have more respect for the opinions of their equals than for the opinions of those who, in position and rate, rank only with their own staffs. That is the first step gained, and it is an important one, for, having once gained the respect of those with whom he comes in contact, the progress-man has justified his position, which he cannot fail to hold if his capabilities are equal to the demands made upon them.

The Progress Department is the mouthpiece of the works manager, the direct link between the management and the works, and when the demands of the department are made the foremen recognise them as the demands of the works manager, and act accordingly. On all matters affecting delivery and output the authority of the department is supreme, and all responsibility in the same connection is accepted by the department. The support of the management follows as a matter of course, and although this does not mean that incompetency is shielded and that every ill-advised action on the part of any member of the department receives the approbation of the manager, it does mean that each progress-man can go about his work with assurance, secure in the fact that he is anticipating the wishes of the management and that he has its support of any legitimate action he may take.

The department is not of necessity a department of mechanics, for in choosing the personnel the only qualifications considered are those for efficiently carrying out the duties of the department. Progress work is recognised as a distinct profession, and the members have served an apprenticeship in order to become proficient in all branches of that profession. The mechanic is not excluded because he is a mechanic, any more than another man is excluded because he is not a mechanic. Efficiency is the thing which matters, and so long as the man is capable of discharging his duties in an efficient manner, what more is desired?

The system adopted is one which will cater for the peculiarities of the specific line of manufacture; it is understandable, and therefore effective. The Progress Department does not enjoy the doubtful advantage of being the only department which understands the system, and no one can justify wrong-doing with the plea that "he wasn't told," or "he didn't understand." Neither is the Progress Department sectionised to such an extent as to entail duplication and its consequent unnecessary clerical labour, performed by experienced progress-men at a high rate, much to their disgust. Thus is time, money and temper saved, and efficiency increased.

And while the works manager, recognising the value of the Progress Department, staffs it with trained and efficient men, he does not forget that these men will not last for ever. The minor positions in the department are filled with probationers, or apprentices, who are learning, under the direction of the section leaders, the profession they have adopted. They learn what system really is, and what efficiency means, and no matter what particular duty they are given, be it record keeping or "chasing," they are taught to do it thoroughly.

CASE-HARDENING.—Some figures relating to the gas consumption of one of their Revergen furnaces when employed on a case-hardening job are sent by the Davis Furnace Company, of Luton. This furnace is provided with a special type of regenerator, and is fired with town gas at ordinary pressure, the air being introduced at a pressure of 3 in. or 4 in. water gauge. The work consisted in case-hardening 713 lbs. of motor-car gear wheels, packed in six boxes, and the material had to be charged into a cold furnace, raised to 900 deg. C., and maintained at that temperature for eight hours. The furnace was heated up from cold to the required temperature in 70 minutes, with a total consumption of 925 cub. ft. of gas, or 1.29 per lb. of material. In the succeeding eight hours the consumption varied from 275 to 350 cub. ft. per hour, or from 0.38 to 0.49 cub. ft. per lb., the overall consumption for the whole run of nine hours ten minutes being 3,425 cub. ft., or 4.8 cub. ft. per lb. of load.

DETERMINATION OF IRON-CONTENT OF ORE.—Herr R. Fresenius in a German chemical paper proposes certain modifications in the Reinhardt method of determining the iron-contents in iron ore. The 5-gramme sample is digested with 50 cub. cm. of hydrochloric acid (sp. gr. 1.19) instead of 100 cub. cm. as in the original method; after the acid-soluble portion has been collected the insoluble portion is fused with sodium carbonate, dissolved in hydrochloric acid, the iron precipitated as hydroxide, and this again is dissolved in hydrochloric acid and the solution added to the main quantity. After diluting to 1 litre, 100 cub. cm. is treated with 10 cub. cm. of hydrochloric acid (to make the acidity equal to that obtained in the original method), the mixture evaporated to 50 cub. cm., the ferric salts are reduced with stannous chloride, the excess of the latter removed by the addition of mercuric chloride, the whole diluted to 2 litres, treated with 60 cub. cm. of manganese sulphate-phosphoric acid solution, and then titrated with permanganate solution.

The Wild-Barfield Electric Muffle Furnace.

A new type of electric muffle furnace has recently been introduced by Automatic & Electric Furnaces, Limited, Gray's Inn Road, London, designed for running direct from a 500-volt circuit. One arrangement is illustrated in Fig. 1, the heating chamber in this case being 12 in. dia. × 23 in. long, provided with firebrick door, and capable of attaining a temperature of 1,100 deg. Cent. Fig. 2 shows an entirely new type of automatic furnace mounted on two spindles in bearings, for hardening sewing and hosiery needles and fish-hooks in bulk. The furnace is charged with the articles, and when the automatic indicator (not shown in the view) announces the change point of the steel, the whole contents

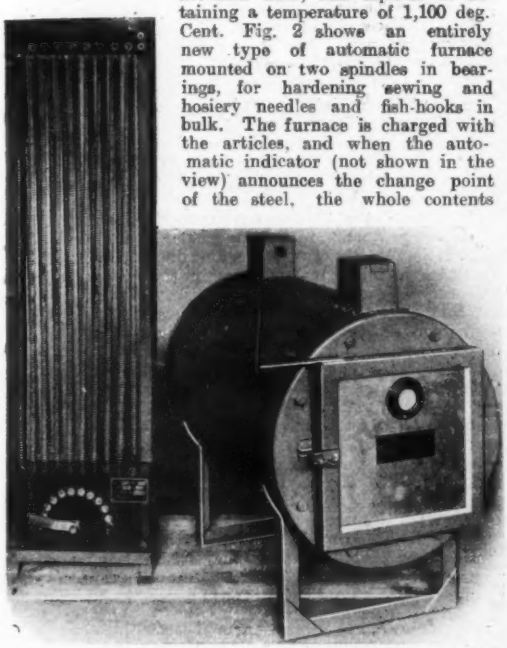


FIG. 1.—WILD-BARFIELD ELECTRIC MUFFLE FURNACE. (RESISTANCE COVER REMOVED.)

are tipped—by means of a lever at the side of furnace—into the tank shown. A fresh charge is then placed in the furnace, and so on. The illustration shows the furnace half-tipped.

The following table gives the output and cost of running for the various size furnaces :—

Size of heating chamber (in inches).	Cost of current (in pence) per hour at 1d. per unit.	Maximum charge (in lbs.).	Approximate output (in lbs.) per hour.
4 dia. × 13 deep	1.4	2	7
6 dia. × 15 deep	2.6	4	10
8 dia. × 17 deep	4.2	10	22
12 dia. × 23 deep	9.5	30	44

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—The opening meeting of the session was held on Saturday, October 25. The proceedings opened with a short address by the President, Mr. Carrington, followed by a Paper by Mr. W. Macfarlane on "The Fuel Question." Owing to the increased cost of running the Institute, notice has been given to the members that at a future meeting they will be asked to sanction an increase in the subscription.

An Inspection of German Brass and Iron Foundries.

The Overseas Department of the British Board of Trade several weeks ago invited the members of the Birmingham brass trade to avail themselves of the British occupation of the Rhineland to inspect some of the German brassworks, of which a considerable number are in that district. The Brassfounders' Association accordingly appointed a deputation of six of its mem-

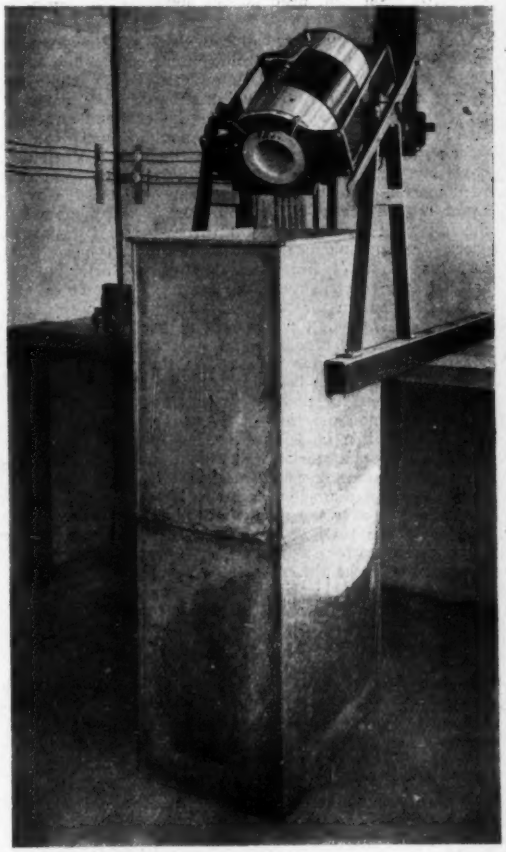


FIG. 2.—WILD-BARFIELD FURNACE, AUTOMATIC TYPE; SHOWN TILTED.

bers, representative of different branches of the brass trade, who spent the last two weeks in July in making a tour of the German factories. The Germans themselves raised no objection to the visit and were fairly communicative in regard to the details of manufacture. The visitors found a great scarcity of labour and a keen desire was expressed by the manufacturers themselves for the return of the German soldiers now prisoners of war in this country. As will have been noted, their repatriation has since commenced. Below we give the report of the deputation :—

In presenting the report upon the Brass Mission in the occupied districts of Germany it has not been considered necessary to individually name the firms visited, nor to give in detail any particular impressions received or observations made upon any specific firms.

The visit was undertaken with the feeling that the German manufacturer was well in front of us in manufacturing methods, which has in the past put him in the position to undersell us in foreign markets, and the impression received after the Mission had completed its work was that the main advantage which the German had in the past over the English manufacturer was in the smaller variety of articles produced by each manufacturer, namely, greater concentration on output, resulting, of course, in a larger turnover, combined with that careful attention to the details of manufacture which is a characteristic of the German, from the head to the humblest employee in the works.

The casting methods appear to offer the greatest divergence from the English system, and while both hand and machine moulding appears to be employed very generally, the following differences were particularly noticed. It appears to be the common practice in all brass foundries to put the moulds in an oven as soon as they are made and leave them there until the next day, such moulds being taken from the oven the next morning and poured during the day and the oven again refilled for re-stoking up for drying a new lot the following night. Both pit furnaces and tilting furnaces are in evidence, several Bessemer-type tilting furnaces made of iron and lined with brick being noticed, this system avoiding the use of crucibles except as a medium for carrying the metal from the furnace to the moulds, in some cases the carrying pots being of iron. The moulds when cored up are placed on top of each other into a pile three or four feet high, and the whole bolted together, after which they are laid on end for pouring in the usual way. It also seems a common practice for the castings to be cut off the ridges when cold by means of a Sprue cutting machine. In one works where hand moulding was in progress, in place of using mallets a heavy metal ball, about 7 in. in diameter, and weighing nearly ½ cwt., was rolled all over the mould in order to compress the sand, and this method would possibly ensure more regular pressure for work which does not vary too considerably in height. It was also noticed in several works that loose locating pegs were inserted in the sand of the mould to assist in the accuracy with which the moulds were matched up.

A visit was paid to the works of a manufacturer of extruded rods in brass, copper, and minimum, also hollow rods. He also manufactured large quantities of hot brass stampings, the work being of a particularly interesting character, such as water-cock heads, valves, crutches, etc., and the opinion held was that this work showed a distinct advance upon the average work in the Birmingham district.

A visit was made to a large firm of metal rollers. The plant was in perfect condition, and the sheet-metal produced was of the very finest quality. We consider that a visit to a works of this character would be of considerable interest to the metal rollers of Birmingham.

It would appear that greater attention is paid to the production of sheet brass than obtains in Great Britain, the utmost care being taken in the removal—both by chemical and mechanical processes—of oxides and foreign matter from the surface of the metal before rolling, thus resulting in a much finer product. It appeared also that the slitting of sheet brass was done very much better than is generally the case in Great Britain, and much greater accuracy and cleaner-cut edges are obtained, a minimum of waste in the working up being, therefore, possible.

A visit was paid to one of the largest makers of semi-rotary pumps, who combine also the manufacture of sluice valves, horizontal vacuum pumps, etc. The works are large, and at present employ 2,000 hands; before the war they employed 3,000, and during the war 4,000 to 5,000.

The ironfoundry is very large and well-planned. They use various types of moulding machines, hand rammed, pneumatic and hydraulic, to suit various jobs. Their best machine is hydraulic, and they are making flat covers, etc., on these, and each machine turns out about 100 complete boxes per day. Their iron castings are clean, good-looking, and of easy machining qualities. They blow once per day. Their cupola arrangements are good, but nothing specially different from good English practice. The brass foundry is a good, roomy place, the melting and pouring being carried on in a separate room from the moulding. They appeared to be using odd scrap which is melted in large tilting furnaces of iron with firebrick lining—both coke- and oil-fired with forced draft. The use of automatic machines was greatly in evidence, but, generally speaking, the speed at which they were running was slow. The internal machining of sluice valves was effected by a double-headed facing machine, each head being set at the same angle and operating simultaneously. It was not found necessary to test more than 10 per cent. of the pumps owing to the perfect castings and machining thereon.

Throughout the tour it was generally observed that a larger proportion of young male labour was employed than is the custom in Birmingham, and they appeared to take great interest in their work, which was very efficient. Up to the age of 18 these youths are compelled to attend continuation schools for three nights per week, and do not qualify for any adult trade union conditions until the age of 24 years.

None of the manufacturers visited were working at their full normal output owing to shortage of labour, and in some cases to shortage of material, but we would again like to emphasise the fact mentioned in our opening remarks, namely, that one of the most noticeable facts was the absence of multiplicity of patterns, which prevents the Birmingham manufacturer from concentrating his output in such a way that the turnover can be increased with less supervision.

It should be borne in mind that the German has a considerable advantage over the British manufacturer at the present time in the fact that the rate of exchange is such that to the export buyer the prices are exceedingly cheap, and until this rate of exchange becomes more normal he will be able to outbid the British manufacturer for the export trade in all those articles where the larger proportion of the labour and material is produced in his own country.

It is practically impossible in a report such as this to describe in detail all the points which might be of interest to individual manufacturers. The members of the Mission, through Mr. J. W. Madeley, will be prepared to discuss, as far as possible, any points arising out of this report.

Supplementing the above report we have ascertained from the visitors that the German working day differs very little from that in operation here, running to 48 hours per week, while wages are about the same. In view of the low value of the mark and the poor purchasing power of German money, added to the very high cost of living generally, the visitors conclude that the worker's lot must be one of some hardship, although they met with little or no complaint.

A good deal of concern prevails in Birmingham with regard to prospective German competition, which it is concluded must be greatly assisted in the open markets of the world by the very low rate of exchange.

STEELWORKS OBJECTED TO.—At a meeting of the Chester City Council, on October 8, a petition signed by niney-two residents in the neighbourhood of Curzon Park was received protesting against the proposed erection of steelworks, and in order to give the Council power to say whether works should be erected on the site or not, it was decided to prepare a town-planning scheme for the city.

The German Iron and Steel Industries.

The information given below has been abstracted from recent issues of the German newspapers:—

Iron and Steel.

The Pig-Iron Syndicate is about to meet to settle prices as from the beginning of October. It is as yet uncertain whether quotations will be raised, as this will depend on the future prices of iron ore and coke. A great scarcity of pig-iron prevails. The output was increased in July, but is reported to have continually declined since the end of August owing almost exclusively to the prevailing dearth of coke.

It is stated that the following works in Lorraine are to be disposed of in the course of a few days:—The Rombach Ironworks, the Thyssen Steel Works at Hagondingen, and the Kneuttingen ironworks of the Lorraine Ironworks and Mining Association. Besides these, the rolling mills and constructional works of Wolf Netter and Jacobi, of Strassburg, are also to be sold. An offer of £520,000 is reported to have been made by a French company for the last-mentioned firm's rolling mill at Kehler. On the other hand, the scheme for the transfer to French ownership of the Dillingen ironworks is making no progress.

The supply of Swedish iron ore to the United Königs and Laura Hütte has been interrupted for a time owing to the sudden failure of transport facilities, and the situation has been further aggravated by strikes of harbour workers in Sweden. As a consequence the company has blown out two furnaces. On the other hand, a third furnace has been started by the Donnersmarck Hütte as a result of the more favourable turn taken by the pig-iron trade. In the case of a third Upper Silesian works—the Bismarck Hütte—it is stated that negotiations have been opened with an American financial group with regard to an extension of the company's sale organisation on the American Continent. The company proposes to establish independent sale departments abroad, which are to work in connection with an already existing organisation of a well-known American group. It is also stated that the company received a few weeks ago an order from South America of the value of 16,000,000 marks (£800,000 at par).

The name of the Fritz Neumeyer Company, Bavarian Ironworks, of Nüremberg, is now put forward as the prospective purchaser of the Bavarian ordnance works of the Krupp Company at Munich.

The Mauser Small Arms Factory, of Oberndorf, is to suspend manufacturing arms on October 15, preparatory to changing over to a new branch of industry.

The representatives of wagon building concerns assembled the other day to consider the question of forming a general syndicate, and have adopted a resolution protesting against the Government's proposal to raise the ban on exports.

Modern High-Speed Steel.

Mr. John A. Matthews, in a Paper presented at the recent annual meeting of the American Society for Testing Materials states that the greater part of the systematic investigation recently conducted by him was confined to four steels, the analysis of which are given in a table below. These steels cover a range as regards their chromium, tungsten, and vanadium content. No. 31 represents a type which was fairly generally used about ten years ago; in fact, various writers, as the result of practical tests, have contended that tungsten above 13 or 14 per cent. is of no advantage. Practical experience, however, has led for the most part to higher tungsten percentages. No. 34 is introduced because it corresponds quite nearly with the analysis of steel to which Mr. Taylor referred as giving the best results obtained with any steel at the time he was actively engaged in this work. As the result of an exhaustive series of cutting tests made as nearly as possible in accordance with the methods outlined and recommended by Mr. Taylor, these four steels will rank about as follows, starting with No. 33 as 100 per cent. efficient:—Steel No. 34 would be represented by 70 per cent., No. 32 by 66 per cent., and No. 31 by 45 per cent.

Steel. No.	Carbon. p.c.	Silicon. p.c.	Manganese. p.c.	Chromium. p.c.	Tungsten. p.c.	Vanadium. p.c.
31	0.63	0.19	0.26	4.31	13.10	0.25
32	0.61	0.19	0.36	3.34	18.28	0.40
33	6.63	0.27	0.31	2.99	16.87	0.85
34	0.64	0.22	0.24	5.35	18.99	0.15

Starting with hardening temperatures at 1,800 deg. Fah., and carrying them up to 2,400 deg., the electrical resistance, the scleroscope hardness and the coercive force increase fairly uniformly with the hardening temperature up to about 2,300 deg. There is a slight tendency to show a reversal of these properties beyond this temperature. Magnetic induction and residual density are lowered as the hardening temperature increases.

If these steels, hardened at proper temperatures to develop full austenitic structure, are subjected to tempering varying from room temperature up to 1,200 deg. there is a general falling off in the hardness, resistance, and coercive force as the drawing temperature is increased. This is not in accord with statements made that there is no effect in drawing the temper of high-speed steel until 932 deg. has been reached. It is true, however, that the effect upon these properties is only slightly influenced below this temperature, while the rate of change increases fairly rapidly at temperatures above 900 deg. There is no indication, as regards magnetic properties, of anything corresponding to the secondary hardening referred to by Mr. Edwards, nor has it been found in connection with scleroscope tests. In cases where the Brinell method is used the author has found it difficult to get constant results with materials so extremely hard, but with that method he found an indication of re-hardening, or secondary hardening at high drawing temperature, the maximum usually being at about 1,100 deg. Fah. The lower the temperature at which the initial hardening is done, the lower will be the temperature at which the re-hardening occurs on tempering, and presumably the sooner a tool so treated will fail in severe cutting where the frictional temperature is high. When the temperature in cutting is not extremely high, one cannot conclude that the steel will fail sooner than one with a higher re-hardening temperature. In such cases physical or mineralogical hardness plays an important part as distinguished from red hardness; but where the cutting conditions are severe it appears logical that the higher the temperature of red hardening, the longer the endurance of the tools.

The tests were for the most part made upon hot rolled 1 × ⅝-in. bars in just the condition that might have been used for cutting tests or for supplying to users. After all heat treatments, however, the surface was examined by file testing to see that no unreasonable decarbonisation had taken place. There was some slight decarbonisation of surface in all cases. For determining hardness it is necessary therefore to remove, by grinding, sufficient material to get below any possible decarbonised or oxidised zone.

To make these tests with scientific accuracy requires conditions of heating and temperature control much more refined than are usually found in industrial plants, and it would be desirable to operate on round pieces which could readily be rough turned prior to any treatment, and ground on centres after each treatment to insure making the test on perfectly sound material. This removes such methods from the kind of tests that

Mr. Taylor had in his mind, as they introduce the same element of expense and require the expenditure of considerable time.

The most noteworthy change is in the introduction of vanadium, which is now used in practically every high-speed steel; in fact, it is the only general addition that has been made to the earlier types which seems to afford universal improvement in quality. Vanadium seems to have conferred general benefit upon all tungsten-chrome and molybdenum-chrome high-speed steels. The use of cobalt received considerable attention a few years ago, but it was noted that it was always present as an addition to types of steels that would have given remarkably good results without it. The use of uranium has been advocated during the past few years, but it seems to be difficult to handle owing to the ease with which it is oxidised, and so far as the author's experiences goes, he has been unable to see that it confers any specific benefit. Such steel as he has examined has been more apt to show seams and surface defects than steel in which it is absent, and the micro-structure of the steel itself usually indicates the presence of considerable amounts of material that are suspected of being oxides of uranium. It should be noted that when oxide of uranium is formed in melting, it has small chance of being eliminated in the slag owing to its great weight. It may be that with more experience means will be found of introducing this material into the bath without such great loss of expensive metal and without the formation of impurities in the steel which cannot but prove detrimental. Other elements have been tried, including cerium and zirconum, but no conclusions are available as yet.

The term modern high-speed steel, therefore, may be considered as referring to the product since the introduction of vanadium, as no generally accepted improvement has been made in high-speed steel since that time. Improvements have resulted in the general quality of the material available, due to greater skill in manufacture, and to the availability of superior raw materials in the form of metals and ferro-alloys than were obtainable in the early days of the industry. It seems that steelmaking rather than chemical analysis is the first consideration, and so far one is not able to define or to specify all the elements which enter from the melting to the finishing of the bar, to produce first-class material over a wide range of analyses, and no physical or chemical test has yet been developed which helps one very much in determining the matter of quality.

ESTIMATION OF MAGNESIUM IN THE PRESENCE OF THE ALKALIES.—In a recent issue of the "Revue de Metallurgie," Mm. Nicolardot and Dandurand point out that in the analysis of glass, silicates and certain alloys, it is frequently necessary to exactly determine the magnesium required to separate this element from the various alkali elements present. We give a summary of the methods studied:—(1) The phosphate method, (2) the Shaffgotsch method, (3) the baryta method, (4) the lime method, (5) the oxalic or oxalate of ammonium method, and the (6) Bengelius method, using oxide of mercury. As a result of their researches the general opinion is confirmed that the method of precipitating magnesia in the presence of alkaline salts, using ammonium phosphate is the best. The only danger in this method is that of the addition of too large an excess of ammonium phosphate reagent. The correct procedure is to use an ammonium phosphate solution of known strength and to add gradually a predetermined amount of this solution necessary to precipitate the magnesium present in the sample. The amount necessary can be determined on a sample not required for the subsequent determination of alkalies. Further details of the other methods are also given. The same authors, in conjunction with M. Levi, also consider the methods of estimating manganese in special steels containing chromium and tungsten.

The Influence of the Six-Hour Day on Industrial Efficiency and Fatigue.*

Lord Leverhulme suggests that, instead of the usual eight-hour shift system, in which, as a rule, the machinery is running only forty-four hours a week, the workers should be put on to two six-hour shifts every day, viz., from 7 a.m. to 1.30 p.m., and 1.30 p.m. to 10 p.m., with half-hour breaks for meals. By this means the machinery would be kept running for seventy-two hours per week, and, as the overhead charges for machinery are often higher than the cost of wages, it would still be possible to pay the workers as much for six hours' work as for eight hours' work, even if their rate of production did not improve in consequence of the shorter hours.

The available evidence does not indicate that there would be much improvement of output in many industries. In the tinplate trade the mill-men sometimes work eight-hour shifts, and sometimes six-hour shifts, and their hourly output was found to be only 10 per cent. greater in the latter instance than in the former. In the iron and steel industry a reduction of shift from twelve to eight hours caused no increase of hourly output from blast furnaces and rolling-mills, but 2 to 9 per cent. increase from open-hearth steel furnaces. In the cotton-spinning mills of the United States a reduction of two or three hours in the weekly hours of work caused an almost proportional decrease of output. However, very different results were observed in certain munition industries. Men engaged in the somewhat heavy operation of sizing fuse bodies increased their hourly output 39 per cent. when their nominal hours were reduced from sixty-seven to fifty-six per week, and their actual hours of work from 58.2 per week to 50.6 per week, or their total weekly output went up 21 per cent. Women engaged in turning aluminium fuse bodies on capstan lathes improved their hourly output 56 per cent., and their total weekly output 15 per cent., when their hours of actual work were reduced from 66.0 per week to 48.6 per week. The reason why reduction of hours causes such different effects in different industries is because of the various degrees to which the work is controlled by the personal element, and by machinery. In sizing fuse bodies, the men are not dependent on any machinery whatever, and can speed up to any extent they wish. In turning fuse bodies, the women are to some extent limited by the speed of the machinery. In another operation known as boring top caps, the youths employed fed the caps into semi-automatic machines which could not be speeded up. Consequently their output could only be improved by their keeping more closely to their work, and it was found that when their hours of actual work were reduced from 72.5 per week to 53.1 per week, their hourly output increased only 27 per cent., or was insufficient to balance the reduction of hours, and in consequence their total weekly output fell off 7 per cent.

It is probable that in most industries the eight-hour day does not cause more than a moderate amount of physical fatigue. The workers suffer rather from monotony and boredom, as many of them are engaged on the same task day after day, and year after year. Especially on these grounds it is to be hoped that some such scheme as Lord Leverhulme's will gradually be adopted in the industrial world, but it cannot come suddenly, as it might render us unable to compete in the open markets of the world with other countries which adopted, for instance, two seven-and-a-half-hour shifts per day, instead of two six-hour shifts.

Lord Leverhulme suggests that, in addition to six hours' factory labour, the workers should spend two hours daily in educational and physical training. There is much to be said for this plan.

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* Abstract of a paper read before the Physiological Section of the British Association, by H. M. Vernon, M.D.

Extensions to the Birmingham Works of the Phosphor Bronze Company Limited.

The Phosphor Bronze Company, Limited, have carried out some important extensions to their foundry at Chester Street, Aston, Birmingham. The Company came into being in the early seventies, the original patent for phosphor bronze being, as a matter of fact, exploited by them. The possibilities of phosphor bronze are now so generally recognised that it is scarcely necessary even to summarise the special characteristics of these. However, the most important are, (1) its resistance to corrosion and acid waters, (2) the small effect which rise of temperature has upon its mechanical properties, and (3) the fact that whilst phosphor bronze of high phosphorus content is sufficiently hard to resist abrasion well, it possesses a lower friction co-efficient than most metals. To meet these conditions it is of course essential that the compound shall be perfectly clean and free from all injurious and foreign matter. In the alloy manufactured by the Company, neither scrap material nor compounds obtained from the re-melting of ashes or drosses enter into the mixture; the makers being thus able to produce a pure, uniform and homogeneous alloy. The firm purchase the scrap of their own phosphor bronze, and this is used in the manufacture of the Vulcan Brand alloys which are put upon the market to meet these cases where first cost must be considered.

With the old plant at the Company's foundry, castings were poured up to 4 tons in weight. When, however, the new plant is in commission it will be possible to produce castings up to 10 tons in weight. The firm make a speciality of phosphor-bronze chill-cast bushes and sticks, suitable for machining into small parts. One advantage claimed for the chill casts is a more homogeneous metal, as owing to the instantaneous cooling of the mass no segregation occurs and the process gives a smoother and cleaner casting, with an absence of the hard outer skin, as in a sand casting, and is also truer to size than the latter, less machining being required. Further, the sudden cooling of the metal, which prevents any lines of cleavage, considerably increases both the elastic limit and the ultimate breaking strength.

The foundry at present consists of three groups of shops, known respectively as the Old Foundry, the New Foundry, and the last extension—the Avenue Foundry. The Old Foundry comprises the casting shop, served by natural-draft pit furnaces of a total capacity of thirty-eight 300-lb. pots, one portion of the building serving as the fettling shop for the whole of the works.

A complete system of overhead runway is laid throughout the works, serving the foundries, the fettling shop, the machine shop, and the stores. There are two coke-fired drying stoves, each 16 ft. square, and a small sand-blast plant, with motor-driven compressor. A Sturtevant dust-collecting plant is being installed in the fettling shop. Adjoining the foundry are the ingot casting shop, the phosphor shop and the machine shop. The latter has the usual equipment of machine tools, motor-driven from line shafting, and a hydraulic plant for testing pumps. The pattern shop is placed in a gallery above the machine shop.

One end of the New Foundry is fitted up as a core shop, the machine for making the cores for the chills being of the Company's own manufacture, as are also the 9 moulding machines. The melting plant consists of a pit furnace for nine 300-lb. pots and nine Morgan forced-draft tilting furnaces (four of 400-lbs., and five of 250-lbs capacity).

The Avenue Foundry was a separate building, but the division wall was removed, and it then formed an extension to the New Foundry. The melting plant consists of a Carr pit furnace for fifteen 300-lb pots. When the change-over is completed, the tilting furnaces will be arranged in a parallel line with the pit furnace, both sets of furnaces being served by a bogie travelling on a track which will deliver the coke to the furnace, and also the weighed charges of metal from the stores. At the opposite end of the building there is a natural-draft pit furnace for twenty 400-lb. pots. A corner of the building is laid off for chill casting, and this has its own pit furnace for three 200-lb. pots. The Monometer chills have been adopted, the feature of which is the locking of the halves by screwed handles, thus doing away with the more or less cumbersome arrangement of rings and wedges. There is a casting pit in the foundry, 16 ft. deep by 12 ft. in dia., which allows of lengths up to 30 ft. being cast. The two drying stoves, which are coke-fired, are 22 ft. by 12 ft. by 12 ft. and 22 ft. by 12 ft. by 9 ft. respectively. They are built with ferro-concrete roofs, so as to provide storage room for boxes, etc., and served by two steel bogies which run on lines of track and are each capable of handling weights up to 50 tons.

The finished stores and the rough stores adjoin the Avenue Foundry, and these, as already stated, are served by the furnace bogie, as also by the overhead runway. Storekeeper's and time-keeper's offices are provided, and a 10-ton Avery weigh-bridge at the gateway entrance. The offices have been extended, and a laboratory and an electric sub-station have been built.

ELECTRICAL CLEANING OF BLAST-FURNACE GAS.—In a recent issue of the "Blast Furnace and Steel Plant," Mr. W. H. Gellert remarks that the removal of dust and fume from blast-furnace gas while at the same time conserving the sensible heat of the gas is a difficult problem, and the dry system has not been successful so far owing to the non-removal of fume. By the Cottrell system of electrical precipitation it has been found possible to remove practically all of the dust from the gas, including zinc and potash fume. The latter is of importance apart from its intrinsic value, when the elimination of the fluxing of stove bricks is taken into account. The potash content is greater in ores used in the manufacture of spiegeleisen and ferro-manganese, and manganese ores usually contain considerable quantities of zinc. Under various conditions of working the use of electrical precipitation on blast-furnace gas has effected a removal of from 89.7 per cent. to 93.4 per cent. of the dust and fume. About 50 per cent. of the total dust coming from the furnace is collected in the dry dust catcher, and contains less than 1½ per cent. K_2O. The fine dust collected by the precipitator contained from 2.74 per cent. to 20.79 per cent. of water soluble potash (K_2O) when gases from pig-iron manufacture were treated, and even when the potash recovery is insignificant electrical precipitation secures a dry-clean gas for use in the hot stoves or boilers.

Moulding a Large-Diameter Five-Way Flanged Pipe.

By C. Thomas.

The accompanying illustrations show the method adopted for dealing with a large-diameter loam pattern of a similar design to the smaller pipe discussed in a previous article.* In this case the branch is made loose and fits into a seating or recess in the main body core. The core for the branch is made slightly over size at the end where the flange is fitted and slightly under size at the seat end. The method of sweeping up is shown in Fig. 6. Two circular plates are cast, one for the top and the other for the bottom, and lifting staples, lugs, etc., for bolting together, are provided in both plates. It will be observed that the core is made the wrong side up for use, and as a result of having the lifting staples in both plates, it is quite easy to turn this over. Care must be taken to screw the bolts up tightly to clamp the brickwork together, or otherwise, when turning over, this brickwork is liable to move.

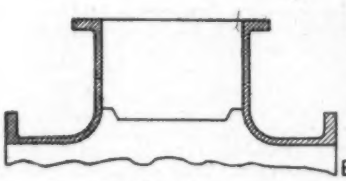


Fig. 1.

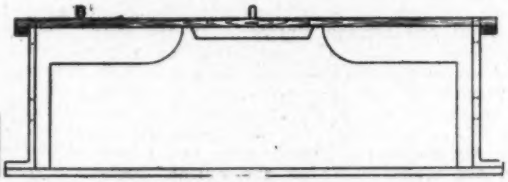


Fig. 2.

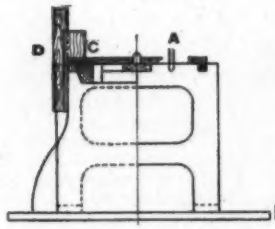


Fig. 3.

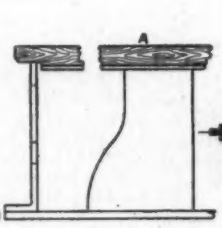


Fig. 4.

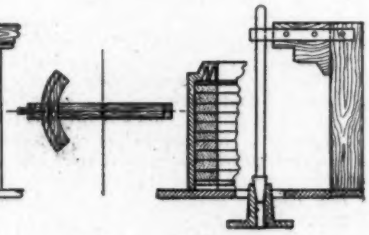


Fig. 5.

Fig. 6.

The thickness of the branch core is formed by wrapping the core loosely with straw bands, and after cutting the thickness out of the core board, the core is swept up again in the usual way. The length of the thickened core should be left 1-8 in. or 3-16 in. longer than required, so as to allow for adjustment when assembling the pattern. The brackets for fastening on the core plates are made 1½ in. higher than the top of the angle, as shown in Fig. 2, and a recess is cast in the centre of each plate to take the wood bar carrying the centre pin used for sweeping out the seating to receive the branch core. Before making this seating, the main core is made the correct height to the branch joint. This is done by using a strickle, as shown at A, in Figs. 3 and 4.

This strickle runs on the brackets, and the recesses in these are filled up with loose pieces of wood to allow the strickle to pass over them. When this has been done, the pieces are taken out and the long wooden bar, marked B in Fig. 2, is placed in position. This carries the centre pin on which revolves the "sweep," shown in Fig. 5. At this stage it is advisable to rough out the shape of the seating in the main core and also the outside diameter. After drying, care must be taken to trim the top to the long strickle A, after which operation the sweep and centre bar are placed in position. It will be noticed from Fig. 3 that a block of wood marked C, with a recess or groove down the side is fastened to the top side of the arm that carries the sweep. On the under side of the arm at each end two pieces of wood are fastened, of a thickness equal to the depth of the strickle from the top of the brackets. By keeping these down on the true face left by the strickle A, the block C is kept at right angles to this face. After sweeping the seat up, the strip of wood marked D, Fig. 3, is placed in the recess or groove in the block C. By moving this up and down the groove, the whole of the outside diameter of the branch seating may be swept up. A radius on the end of this strip is also necessary to form the angle. If the branch flange is fastened or weighted down when the pattern is rammed up, and the straw bands have not been too tightly wrapped, the core can be drawn through the cope before this is lifted off. It is then an easy matter to remove the thickness from the mould when the cope is lifted off. This method will leave a much better mould than drawing the whole branch together with the thickness through the cope. The core should be well packed down and also rammed with sand before casting. The core is shown in position in Fig. 1.

* September issue page 659.

Trade Talk.

MESSRS. C. P. SANDBERG, inspecting engineers, have removed to 40, Grosvenor Gardens, S.W.1.

THE existing £10 shares of the Hardy Patent Pick Company, Limited, are to be divided into ten shares of £1 each.

VICKERS, LIMITED, have offered Infield House and grounds near Furness Abbey for use as a convalescent home as a war memorial for Barrow.

ONE of the furnaces at the South Wales Works, Llanelly, of Richard Thomas & Company, Limited, was practically destroyed recently by an explosion.

THE capital of the Prince of Wales Dry Dock (Swansea), Limited, has been increased to £100,000, and the £10 shares have been sub-divided into ten shares of £1 each.

GUY MOTORS, LIMITED, are engaged upon extensions to their Fallings Park Works, Wolverhampton, which, when completed, will enable them to double their present output.

MESSRS. MADDON & Co. are building works at Park Lane, Fallings Park, Wolverhampton, where they propose to specialise in the manufacture of high-class machine tools.

THE directors of the Dalmellington Iron Company, Limited, propose to sub-divide their £10 shares into ten shares of £1 each. The capital of the company is to be increased.

JOHN LYSAGHT, LIMITED, propose to capitalise the reserve fund by increasing the ordinary capital of the company to £2,000,000 by the issue of bonus shares to the ordinary shareholders.

CLAYTON & SHUTTLEWORTH, LIMITED, have taken important orders for Pullman cars from the Indian State Railways, the Caledonian Railway, the Great Eastern Railway, and the Pullman Company.

THE imports of foreign iron ore at the Senhouse Dock at Maryport for September have been 6,800 tons, compared with 12,900 tons for August and 10,800 tons for the corresponding period of 1918.

THE shareholders of Babcock & Wilcox, Limited, met in London on Sept. 18, when the resolution passed on September 1 increasing the capital to £2,460,000 by the creation of 500,000 additional ordinary shares of £1 each was confirmed.

THE CHARCOAL IRON COMPANY, LIMITED, of Backbarrow, near Ulverston, were able to keep their furnace in operation during the strike, making hematite charcoal cold-blast pig-iron, as they had ample stocks of charcoal, ore, etc.

THE shipyard at Warrenpoint, Co. Down, recently controlled by the Admiralty, has been purchased by a group from Belfast, Liverpool and Glasgow, the principals being Mr. J. Sinclair, of Glasgow, and Mr. A. Rowland, of Liverpool.

ALL business in connection with Hyatt roller bearings, hitherto conducted by Broom & Wade, Limited, Desboro' Iron Works, High Wycombe, is now carried on by Hyatt, Limited, 24, Devonshire Street, Southampton Row, London, W.C.1.

WALTER P. NOTCUTT, LIMITED, 8, White Street, Moorfields, London, E.C., have re-engaged their men as they became demobilised from active service, and have added Mr. C. T. Richardson and Mr. G. H. Truman to their staff of representatives.

BEFORE the close of the year the Institution of Engineers and Shipbuilders in Scotland will reoccupy their premises in Elmbank Crescent, Glasgow, which have been used during the war period as the headquarters in Scotland of the Ministry of Munitions.

MR. F. A. YERBURY, 3 and 5, Queen Street, Cheapside, London, E.C.4, has taken up the British agency for the sale of steel castings up to 12 tons in weight, and also for electric furnace steel, manufactured by the Soc. Anon. John Cockerill, of Seraing, Belgium.

THOS. SMITH'S STAMPING WORKS, LIMITED, propose erecting another mill at Walsall, to enable them to meet the growing demand for light sections as used by the sash and casement trade. Previous to the war this trade was largely in the hands of the Germans.

WALTER SCOTT, LIMITED, of Leeds, are supplying the Southend Town Council with 150 tons of steel tramway rails at a cost of £3,700. Messrs. Walter Scott guaranteed delivery in about six weeks, but the American firm were unable to supply the rails for about 3 months.

MR. HUGHES, the Prime Minister, has stated in the House of Representatives of the Commonwealth that the Imperial Government had promised to advance £500,000 for the purpose of fostering the treatment of spelter in Australia, and the Commonwealth would also assist in the establishment of similar works.

AT a recent meeting of the Cleveland ironmasters, it was resolved that in the event of railway-rates being advanced, the selling price of Cleveland pig-iron shall be increased 1¼d. per ton for every 1 per cent. of the advance, and in the case of East Coast hematite the advance is to be ½d. per ton for every 1 per cent.

THE business of Messrs. John Bradley & Company, Stourbridge Ironworks, one of the oldest-established houses in the marked bar trade of South Staffordshire, has been acquired from Mr. W. H. Foster by N. Hingley & Sons, Limited, and E. Baylie & Company, Limited, who will convert the business into a limited liability concern.

THE following headings have been deleted from the list of prohibited exports :—(A) Aeroplane engines and their component parts; (A) telegraphs and telephones, wireless, and instruments and material for wireless telegraphic and telephonic apparatus, including valves. The following heading has been added :—(B) Aeroplane engines and their component parts.

THE directors of Palmers Shipbuilding & Iron Company, Limited, have decided that the proposed capitalisation instead of taking the form of an issue of 700,000 new shares with 10s. paid, shall take the form of an issue of 350,000 new ordinary shares, fully paid, to be allotted to the shareholders in the proportion of one additional share for every two shares held.

THE number of vessels launched in the Tyne during September was five, of an estimated register tonnage of 120,148 tons, as compared with 77 vessels of 15,700 tons for the corresponding month last year. The total from January 1 to September 30 was 66, of 120,147 register tons, as compared with 77 vessels of an estimated register tonnage of 140,773 tons for the corresponding period last year.

APPLICATIONS have been invited by Vickers, Limited, for £1,803,300 Chinese Government eight per cent. Sterling Treasury Notes, 1925-1929, at the price of £98 per cent. The notes are being issued by the Chinese Government to Vickers, Limited, pursuant to an agreement under which Messrs. Vickers undertake to supply commercial aeroplanes and to build the necessary aerodromes, hangars, etc.

THE committee appointed by the Board to Trade to consider and report upon non-ferrous mining in the United Kingdom held its first meeting after the recess on October 13, under the chairmanship of Mr. H. B. Betterton, M.P. It has decided to deal in the first instance with tin-mining, and will proceed forthwith to take evidence. Subsequently the committee will take up the question of zinc and lead mining.

RUSTON & HORNSBY, LIMITED, propose to issue a further 818,568 ordinary shares of £1 each in order to provide additional working capital. This is the balance of the unissued ordinary shares and will bring the total capital of the concern, including debentures, up to £3,000,000. During the last year new workshops have been constructed to meet the increasing demand for the company's products both at home and abroad.

THE agency arrangement which has existed between the Staveley Coal & Iron Company, Limited, of Chesterfield, and Raby, Fell & Company will terminate on September 30, and the Staveley Company are establishing an office for the sale of pig-iron, etc., in

the offices hitherto occupied by Raby, Fell & Company at Grosvenor Chambers, Deansgate, Manchester. This office will be under the management of Mr. G. P. Raundrup.

THE EMPIRE ROLLER BEARINGS COMPANY, LIMITED, having placed their services at the disposal of the Ministry of Munitions and suspended their ordinary business during the war, have now resumed operations at 13, Victoria Street, Westminster, S.W., and will in future be closely associated with Ransomes & Rapier, Ltd., of Ipswich and London. Mr. Thomas W. How, who has been managing director of the company since its establishment in 1901, will resume that position.

A.B.C. COUPLER, LIMITED, Fallings Park, Wolverhampton, have received a large order from the Indian State Railways for "Jones-Watson" company for locomotives, carriages and wagons. The order is for direct shipment. The A.B.C. Company have also received an order through the Crown Agents for automatic couplings for the Nigerian Railway. This last order, it is interesting to note, was placed after a competitive trial with an automatic coupling of American manufacture.

THE export trade in mining and tool steel to South Africa has now been resumed owing to the relaxation of restrictions and better shipping facilities. During the war South African users were compelled to buy from the United States, but they are now returning to their former sources of supply. Messrs. A. Blyde & Company, of Sheffield, inform us that they have now several orders on hand for mining steels for South Africa, and no doubt other firms are in a similar position.

J. SAMUEL WHITE & COMPANY, East Cowes, I. of W., recently delivered to the Navy a new and powerful destroyer of the "W" class. H.M.S. "Witherington" was laid down on July 29, 1918, and launched on January 16, 1919. She is of 1,450 tons displacement, and 28,000 s.h.p. The vessel has been constructed, engined and fully equipped by Messrs. White's, her propelling machinery consisting of two Brown-Curtis geared turbines, whilst her oil-fired boilers are the well-known White-Forster water-tube boilers.

THE DEPARTMENT OF OVERSEAS TRADE (DEVELOPMENT AND INTELLIGENCE) and the British Engineers' Association will shortly despatch to Chile, Peru and Bolivia a joint investigator to ascertain the conditions and prospects for the sale of British engineering products in those markets. The cost of the investigation is being defrayed by the association and His Majesty's Government. The subjects to be covered by the investigator include imports, shipping methods, Customs, tariffs, legislative regulations and restrictions, statistics and competition.

THE LORD CHANCELLOR has nominated Mr. F. Gore-Browne, K.C., to be Chairman of the Rates Advisory Committee to be set up under Section 21 of the Ministry of Transport Act. The names of the members of the Committee who are to be nominated by the Board of Trade will be announced at an early date. One of the first tasks of the Committee will be to advise upon some immediate increase in goods rates to make up the heavy charge in respect of railway working which is at present falling on the Exchequer. In addition, it is probable that the Committee will be asked to advise upon changes in the charges made for detention of railway trucks.

THE BOARD OF REFEREES have issued their decision in several cases under the Finance Act (Excess Profits Duty). In the case of the production of manganese ore in the Iberian peninsula, the statutory percentage has been increased to 12½ per cent. for a company, and to 12½ per cent. plus 1, 2 or 3 per cent. according to accounting periods in other instances. Regarding the mining of fireclay and the manufacture of refractory goods therefrom, the rate for a company is to be 7 per cent., and in other instances 7 per cent. plus 1, 2 or 3 per cent. For lead and zinc mining in Italy, the percentages have been altered to 8 per cent., and 8 per cent. plus 1, 2 or 3 per cent. respectively.

THOUGH the contractors have not yet finished the buildings, work has begun in the experimental station of the Fuel Research Board at East Greenwich. In the forthcoming report of the Board to the Committee of the Privy Council for Scientific and Industrial Research the nature of the experimental work will be explained. Sir George Beilby, the director of the Board, has in his own laboratory converted 25 tons of coal a day into its constituent parts, leaving a residue which was made into fuel for the people of Glasgow at a cost 50 per cent. less than coal. This residue, which was sold at 1s. a cwt., was made up into oval briquettes. It burned without smoke and without much ash.

THE annual report of the Cutlers' Company states that during the year 168 applications for new marks were received. Of this number 66 have been placed upon the register, while 478 marks have been renewed. The Export Committee's work in examining goods proposed to be exported, and examining certificates, came to an end after the conclusion of hostilities, and the Department have thanked the company for the assistance it afforded to the Government in this and other matters during the period of the war. Between May, 1915, and December, 1918, 205,462 certificates were granted by the committee. Referring to the new Trade Marks Bill, the report states that the company as a registering authority will naturally perform to the best of their ability any duties which Parliament may impose upon them, but they view with grave apprehension the policy of introducing second grade trade marks which in their opinion must deteriorate the value of existing registered trade marks, and put the holders thereof to the expense of constant opposition.

MR. JOHN SLATER has acquired the controlling interest in Amalgamated Industrials, Limited. The present issued capital of the company is £1,605,000, and Mr. Slater has applied for and taken up the reserve capital of £1,395,000 ordinary £1 shares, making the total issued capital of the company equal to the present authorised aggregate of £3,000,000. Mr. Slater now intends increasing the capital to £5,000,000, in order to merge his various industrial interests with Amalgamated Industrials, Limited. We are informed that through this expansion of the company it will become substantially interested in Murdoch & Murray, Limited, Ferguson Bros. (Port Glasgow), Limited, New Haden Collieries, Limited, H. Warrington & Son, and other concerns. Amalgamated Industrials will retain the full controlling interest, by virtue of its holding of all the ordinary shares, of its present main assets, including the Clyde Shipbuilding and Engineering Company, Limited, and William Whitwell & Company, Limited. Mr. C. C. Hatry and Mr. P. Haig-Thomas have been invited by Mr. Slater to become joint financial advisers to the new board of Amalgamated Industrials, which will include Mr. Slater and his colleagues, and the heads of the various companies now brought under uniform control

SINCE the outbreak of war to the present time the works of Parsons Marine Steam Turbine Company, Limited, have been continuously employed in their full capacity in the construction of propelling machinery, the total horse-power of these installations completed during the period of the war amounting to 664,900. In addition, mechanical gearing was constructed for other marine engineering companies, the total horse-power amounting to 721,100. Further, in addition to the foregoing, the work of cutting teeth in gear wheels and pinions was completed for other marine engineering companies for vessels having a total of 1,578,200 horse-power. The application of geared turbines to marine propulsion, on the system initiated by the company, continues to make great progress. In October, 1918, the directors decided to make arrangements for the extension of the machine shops, by the erection of an additional large bay, to increase the facilities for constructing turbines and gearing; this bay is now almost completed. The directors con-

tinue to recognise that great importance must be attached to experimental investigation of the numerous and difficult problems which influence the efficiency of marine steam turbines, gearing and screw propellers, and they have, therefore, increased the provision for experimental, pioneer and development work to £150,000.

THE PRESIDENT OF THE BOARD OF TRADE has established an internal administrative council which includes the Parliamentary and permanent secretaries and the heads of the chief administrative departments. The council will meet regularly and frequently to deal with current business involving questions of policy. Sir H. Llewellyn Smith, permanent secretary of the Board of Trade, has been appointed to the post of economic adviser with reference to the larger national and imperial economic questions, especially for the present those arising out of the peace settlement and the transition to normal conditions. He will retain close connection with the Board of Trade in the capacity of vice-president of the administrative council, over which he will preside in the absence of the President of the Board of Trade. In order to fill the vacancies caused by the appointment of Sir H. Llewellyn Smith and the transfer of Sir William F. Marwood to the Ministry of Transport, the President of the Board of Trade has appointed Mr. S. J. Chapman (senior assistant secretary, General Economic Department) and Mr. H. A. Payne (Comptroller of the Companies Department) to be joint permanent secretaries of the Board of Trade. The administrative council referred to above is quite distinct from and in no way supersedes the Board of Trade Advisory Council on which manufacturers, traders and labour are represented.

THE announcement is made of one of the largest amalgamation schemes which has latterly been carried through in the engineering trade. The firms that have amalgamated are Aveling & Porter, Limited, of Rochester; E. H. Bentall & Company, Limited, of Heybridge; Blackstone & Company, Limited, of Stamford; Richard Garrett & Sons, Limited, of Leiston; and James & Frederick Howard, Limited, of Bedford. These names are all household words in the engineering industry of the country, and most of them have been established well over one hundred years. The amalgamation will be known as the Agricultural and General Engineers, Limited, with a capital of 3,000,000 sterling, formed with a view of employing a large amount of British labour on mass productions. The firms entering the amalgamation will in no sense lose their identity, nor is the management to be changed, the whole object of the amalgamation being massed production and efficient selling organisaton. The various works will specialise in their chief products. They will be greatly extended and already a considerable amount of this work and the purchase of new tools has been undertaken. The head offices of the amalgamated concern will be at Central House, Kingsway, London, W.C., but until the Government Department, which is now in possession of Central House, have removed, the temporary offices are at 50, Pall Mall, London, S.W.1.

SIR AUCKLAND GEDDES, President of the Board of Trade, received a deputation consisting of members of the Association of British Motor and Allied Manufacturers, and representatives of British makers of motor tractors. The deputation asked that the import duty of 33⅓ per cent. already applied to private motor-cars and motor-cycles should be imposed on all motors, and remain in force till the end of 1921. They also asked for a limitation of the number of commercial motor vehicles allowed to be imported till the end of 1920. The President of the Board of Trade maintained that, in the case of private motors, the actual rate of protection now was 88 per cent.—33 per cent. duty and 45 per cent. as the result of freights, charges, packing, insurance, the rate of exchange, and so forth. In the case of commercial motors, to which the 33 per cent. *ad valorem* duty does not apply, he maintained that there is an actual protection of 45 per cent. His view was that the trade had nothing to fear from America for some time to come, and he contended that unless America took more goods from us she was not likely to flood our markets with Ameican goods. He looked at the question of the exchange *vis-à-vis* America, and, while he maintained that the industry was sufficiently protected from the most likely competitor, the one in the West, he promised that the Government would see that the industry was not ruined by competition from the East—the Continent of Europe—where the exchanges might have a disastrous effect. He admitted that the Government could not at present fix a permanent policy regarding imports, because of the economic turmoil in the world, and said they must deal with problems as they arose.

THE directors of Crossley Brothers, Limited, propose to capitalise £190,104 of the undivided profits, and to issue a corresponding amount of fully-paid £1 ordinary shares ranking for dividend from July 1, 1919, and carrying the same rights and privileges as the existing ordinary shares. The distribution of these shares will give each ordinary shareholder one fully-paid ordinary share in respect of every three ordinary shares. During the past five years large extensions were made necessary by war conditions. A plot of land of more than double the area of the Openshaw Works was purchased at Heaton Chapel and a new factory has been erected there and equipped with machinery. The whole of the company's existing works are fully occupied, and in view of the great demand for the company's products further extensions at Heaton Chapel are being arranged for which will ensure large increases in production under better and more economical conditions than in the past. The directors have acquired on behalf of the company the whole of the shares of the Premier Gas Engine Company, Limited, Sandiacre, Nottingham, and they will in future control that company with the assistance of two of its former directors. The directors have also taken, on behalf of the company, a substantial interest in the business of the Saunderson Tractor and Implement Company, Bedford. The present capital of the company is £973,700, divided into 403,390 preference shares and 570,310 ordinary shares of £1 each. It will be necessary to increase the nominal capital of the company in order to create the ordinary shares referred to above, and as the developments named and others which the directors may arrange are expected to give opportunity for a profitable employment of further capital, the directors have decided to recommend an increase in the nominal capital of the company to £2,000,000.

THE first really national conference between manufacturers and merchants recently took place in London, members from all over the kingdom representing the National Federation of Iron and Steel Manufacturers and the British Federation of Iron, Steel, Tinplate, and Metal Merchants. Mr. John Craig, Mr. E. Steer, Mr. H. C. Bond, and Mr. Borough Hopkins were the principal speakers for the manufacturers, Mr. Craig occupying the chair in the absence of Mr. Scobie Smith. The merchants' side of the questions raised was represented chiefly by Sir Johnstone Wallace, Sir Christopher Needham, Mr. John Hall, Mr. H. J. Skelton, and Mr. Gray Buchanan. This meeting was called into being by a desire on the part of the merchants to extend a friendly offer of co-operation with the manufacturers, in order to co-ordinate their policy, and by combined efforts endeavour to increase our export trade. Only general principles were touched upon to begin with, Mr. H. J. Skelton, in particular, giving a very able exposition of the part played in industry by the merchant, and drawing the attention of those present to the fact that the manufacturers in most cases had neither the facilities nor the personnel to cope with the numerous problems concerning banking, exchange, freight, and insurances which were constantly confronting merchants who, by their training and experience, were peculiarly well suited to handle them. Examples were given of how the merchants were treated in Germany and

America, and hopes were expressed by the Merchants' Federation that agreements might be arrived at with the manufacturers whereby the latter would devote their energies entirely to the problems of labour, plant and organisation. The wonderful distributing organisation of British merchants, with agencies all over the globe, was ready to handle their products, pay promptly for them, and distribute them to the ends of the earth. The manufacturers requested the merchants to draw up for their consideration a definite proposal for co-operation, and this is now being taken in hand by the Merchants' Federation.

At a recent sitting of the Royal Commission on Income Tax, Mr. Max Muspratt, Mr. Thos. Biggart and Mr. S. E. Cash appeared as witnesses on behalf of the Federation of British Industries. The first two dealt with the subjects of depreciation, obsolescence, and wasting assets, while Mr. Cash suggested alterations in the method of assessment and administration of the tax. It was laid down as axiomatic in regard to depreciation that allowances should be permitted for the annual reduction in value of all properties which contribute to the earning of the profit assessable for Income Tax, and that this should be effected by writing off fixed annual sums based on the prime cost and measured by the effective life. It was suggested that this principle should apply not only to plant and machinery, but to buildings, foundation, fixtures, leaseholds and patents. The suggestion in regard to assessment were that deductions should be allowed for subscription to trade organisations, for research work, and for sums spent in legal expenses or removal expenses; and that quasi capital expenditure incurred—that is, by the erection of workmen's houses to be let at unremunerative rents—might be recognised as business charges in the true interests of the State. The witness supported the claim already advanced to the Commission that the anomaly of double Income Tax should be removed, not only as between different parts of the Empire but between the United Kingdom and foreign countries; and claimed that to charge super-tax on bonus shares was in effect to tax capital. Among the administrative suggestions were that the basis of assessment should be that of the preceding year instead of an average of years; that the time limit for the hearing of appeals should be increased; that the Surveyor of Taxes should be required to direct the taxpayer's attention to the fact of his being entitled to any concession. Mr. P. D. Leake, who appeared on behalf of the Institution of Mining and Metallurgy, chiefly devoted his evidence to showing that it was equitable to allow to mining undertakings some deduction in respect of wasting assets. He suggested that in so far as the assets of a mining company consisted of (1) the base value of mining rights, (2) the cost of shaft-sinking and access, (3) the cost of plant other than shaft-sinking and access, (4) the cost of development, a reduction in respect of all these inherently wasting assets should be allowed as expenses for the Income Tax. In view of the fact that the State now takes three-tenths of the whole profits, he advocated the setting up of a permanent Commission to determine in each case the proper base value of the mining rights for the purpose of fixing the amount per ton of ore raised to be deducted from the revenue before computing the profits for the division between the State and the proprietors. He advocated on behalf of the Institution the abolition of the three years' average system in favour of assessment on actual profits of the preceding year, losses being carried forward against the profits of subsequent years.

On Thursday, September 18, a luncheon was given by Sir Robert Hadfield, Bart., a member of the Hon. Committee of Experts, in the Pillar Hall, at the Shipping, Engineering, and Machinery Exhibition, Olympia, to a large number of gentlemen associated with the engineering and shipbuilding industries to meet the Right Hon. Walter Long, M.P., First Lord of the Admiralty. Among those present were: Sir J. A. F. Aspinall, Mr W. H. Allen, General R. B. Bagnall-Wild, Rt. Hon. G. N. Barnes, M.P., Mr. P. B. Brown, Rt. Hon. Lord Blyth, Mr. D. A. Bremner, M. J. T. Brownlie, Sir John Cockburn, Professor Coker, Sir Wm. Collingwood, Major A. B. H. Clerke, Rt. Hon. the Earl of Denbigh, Sir Maurice Fitzmaurice, Sir Fortescue Flannery, Sir Henry Fowler, Rt. Hon. Sir Auckland Geddes, M.P., Admiral Sir George Goodwin, Colonel Sir Henry Gould-Adams, Mr. F. W. Harbord, Mr. Douglas Heap, Dr. H. S. Hele-Shaw, General Sir H. C. L. Holden, Mr. Edward Hooper, Mr. Summers Hunter, Rear-Admiral H. Iida, Rt. Hon. A. H. Illingworth, M.P., Mr. A. M. Jack, Sir Alexander Kennedy, Mr. Andrew Laing, Mr. Isaac Lester, Rt. Hon. Walter Long, M.P., Major P. A. MacMahon, Sir J. B. Marshall, Commander F. E. Merino, Rt. Hon. Sir Alfred Mond, Bart., M.P., Mr. S. Thornely Mott, Mr. Percy Minter, Sir Gerard Muntz, Bart., Admiral Sir Henry Oram, Mr. W. H. Patchell, Mr. W. B. Pickering, Mr. S. F. Prest, Sir Vincent Raven, K.B.E., Mr. W. H. A. Robertson, Mr. Anderson Rodger, Captain H. Riall Sankey, Mr. H. J. Skelton, Sir Campbell Stuart, K.B.E., Mr. A. W. Szlumper, Mr. C. Tennyson, Rt. Hon. Lord Terrington, Sir Henry W. Thornton, Dr. J. H. T. Tudsbery, Mr. A. T. Walmisley, Sir Philip Watts, K.C.B., F.R.S., Sir Glynn West, Colonel R. Saxton White, and the Rt. Hon. Viscount Windsor. After lunch there was shown a set of cinema pictures, illustrating the manufacture of steel forgings for marine and other shafting—probably one of the best technical films every presented—from the raw material to the finished shaft; in fact, including the launch of the ship itself. This new forging plant, including new steel-melting furnaces, forging shop containing three large hydraulic presses up to 2,000 tons capacity, heat-treatment shops, machine shops, and other adjuncts, cost nearly half a million sterling, and is probably one of the most complete in the country for this class of work. Such steel forgings for ship and other purposes, which were largely obtained before the war from the Continent, chiefly Germany and Austria, can now be obtained in this country, that is on a large scale, quickly, and of the highest quality. Messrs. Hadfield also have a large and up-to-date forging plant, and undertake the supply of forgings up to 15 tons weight for marine, engineering, and other purposes, either in the rough, rough machined, or finished condition. During the war Hadfields, Limited, melted 630,000 tons of material for their munitions products, 90 per cent. of which was high-class alloy steels. They made 100,000 tons of electric steel. They manufactured and supplied £36,000,000 worth of products, including castings and forgings, railway and locomotive work, for the Government. They turned out 2,500,000 shells of 20 different types for the Army, running up to 15-in. shells, and 1,000,000 shells of 37 different types for the Navy, varying from 22-pounders to 1½ tons; this latter being the armour-piercing shell for the gigantic 18-in. guns. Although they had not made guns prior to March, 1917, they quickly adapted themselves, at the request of the Government, for this difficult branch of production with the greatest success. They turned out 250 complete guns up to 8-in. calibre, 3,500 gun tubes, and 3,400 trench howitzers, together with heavy conning towers for war ships at an exceedingly rapid rate.

MOTOR CYLINDERS FROM TUBING.—According to Mr. W. F. Verner, the Ford Motor Company, in the manufacture of their "Liberty" motors use a method of making cylinders from tubing. This results in a substantial saving when the cost of a solid forging and the subsequent machining operations are considered. The "Liberty" motor cylinder is forged from a high-carbon steel tube 5¾ in. outside diameter, 4¾ in. inside diameter and 39¾ in. mill length. The tube is cut off, the head closed, the head formed, the bosses for inlet and exhaust valves rough drilled, the forging upset and flange formed, and the cylinder heat-treated, in six operations.

MOULDING MACHINES

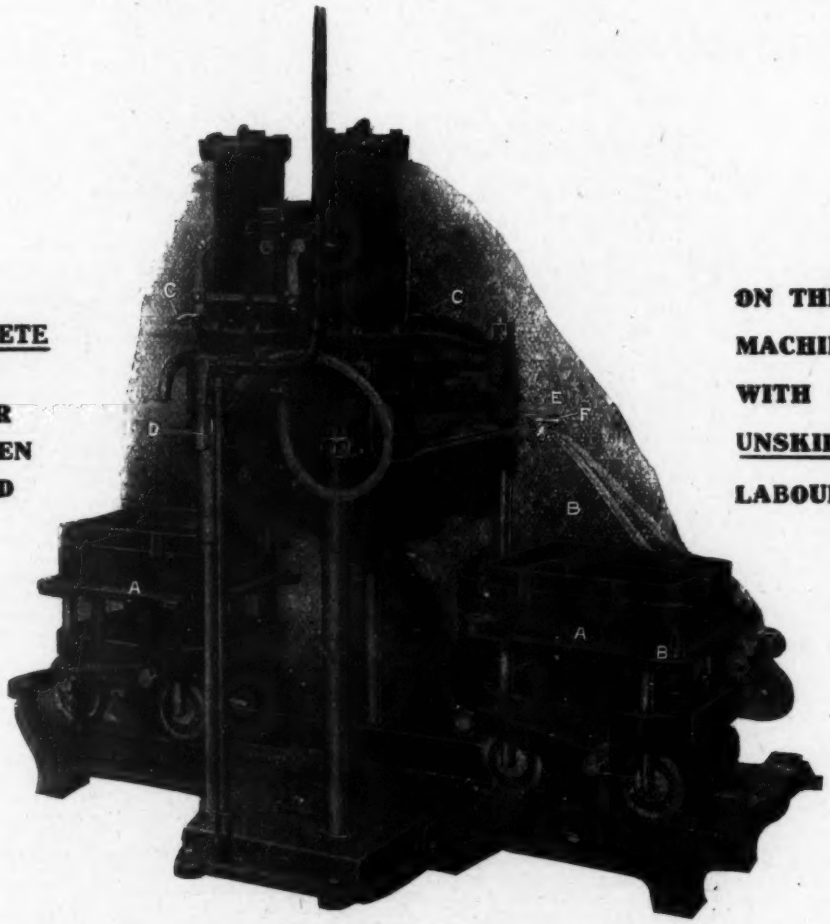
OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.

Type "A" Duplex Machine for Pneumatic Power.

Fitted with self-adjusting Rammer Head which accommodates itself to any varying depth of pattern.

OVER 50 COMPLETE MOULDS PER HOUR HAVE BEEN PRODUCED



ON THIS MACHINE WITH UNSKILLED LABOUR.

One of many that we have installed in various Munition Work Centres.

JAMES EVANS & CO., BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

Personal.

SIR CLEMENT B. SIMPSON has joined the board of Mather & Platt, Limited.

MR. BURTON CHADWICK, M.P., has been appointed a member of the Disposal Board.

MR. TOM MANN has been elected general secretary of the Amalgamated Society of Engineers.

MR. J. H. ASTON has resigned his position as a director of Thomas Smith's Stamping Works, Limited.

THE late Mr. D. Jack, formerly manager of the projectile department at Hadfields, Limited, left £5,727.

THE late Mr. A. Booth, chairman of Joseph Booth & Brothers, Limited, Rodley, near Leeds, left £41,517.

THE late Mr. P. Winn, of Charles Winn & Company, Limited, brass founders, etc., of Birmingham, left estate valued at £43,009.

MR. A. E. DOXFORD has retired from the firm of Wm. Doxford & Sons, Ltd., with which he has been associated all his business life.

THE LATE MR. W. J. REES, a director of the Cwmfelin Steel and Tinplate Company, Limited, left estate of the gross value of £157,559.

THE gross value of the estate of the late Mr. Albert Vickers, formerly chairman of Vickers, Limited, is £886,384, with net personalty £759,747.

MR. A. MITCHELSON, of London and Cardiff, has joined the board of the Chesterfield Tube Company, Limited, in association with Mr. C. Hatry, of London.

THE late Mr. J. Melvin, of R. Melvin, Limited, of Sunnyside Foundry, Alloa, left estate valued at £22,019.

CAPTAIN H. HINCKS has been appointed by the President of the Board of Trade to succeed Mr. J. W. Hands as Controller of the Profiteering Act Department.

MR. G. TURNER, of the Midland Railway Carriage & Wagon Company, Limited, has been elected to a seat on the board of Cammell, Laird & Company, Limited.

SIR LEONARD W. LLEWELYN has resigned his seat on the board of the Ebbw Vale Steel, Iron & Coal Company, Limited, and has been elected a director of John Lysaght, Limited.

MR. JOSEPH CHILTON and Lord Weir have been awarded gold medals by the North-East Coast Institution of Engineers and Shipbuilders for papers read during the past session.

MR. A. J. GRAN, who had been of great assistance to the management of John Brown & Company, Limited, for several years past, has been elected a director of the company.

MR. W. HARGREAVES and Mr. R. M. Currer-Briggs have been elected managing directors of Henry Briggs, Son & Company, Limited, with Mr. H. Currer-Briggs as assistant managing director.

LIEUT. P. J. SYLVESTER (Somerset Light Infantry), a son of Mr. Percy Sylvester, who has been seriously wounded in Russia, has been awarded the Military Cross for conspicuous gallantry in the field.

MR. A. JOHNSTON, J.P., of the Federation of British Industries, and managing director of the North British Rubber Company, Limited, has been appointed a member of the Central Profiteering Committee.

THE council of the University of Sheffield have made the following appointments:—Mr. T. F. Wall, to the post of Lecturer in Electrical Engineering; Mr. W. Burnet to the post of Assistant Lecturer and Demonstrator in Mechanical Engineering.

CAPT. F. G. BRISTOW, general secretary of the Motor Transport Employers' Federation, has been nominated to serve on the London Advisory Committee established in connection with the National System of Employment Exchanges.

WE are informed that Dr. Ormandy and Mr. Harold Moore, M.Sc., Tech., have established themselves as consulting and analytical chemists at 85, Deansgate Arcade, Manchester. We understand that they are making a speciality of fuels and lubricants.

MR. S. H. BYASS, J.P. (Mayor of Aberavon), and proprietor of Messrs. R. B. Byass & Company, Margam & Mansel Tinplate Works, Port Talbot, has presented 1,200 men who enlisted from the borough with a silver pendant and a certificate of honour as a memento of the war.

MR. F. SHEARMAN, chairman and managing director of the Mout Stuart Dry Docks, Limited, Cardiff, has been elected to a seat on the board of J. Samuel White & Company, Limited. Mr. Shearman is connected with several engineering and ship-repairing establishments in South Wales, including the British Arc Welding Company (Bristol Channel), Limited, Gould's Foundries, Limited, John Shearman & Company, Limited, John Shearman & Company (Newport), Limited, and Mordey, Carney & Company, Limited.

MR. W. C. MCARTHUR, assistant works manager at the North Woolwich works of W. T. Henley's Telegraph Works Company, Limited, has retired after being 45 years in the company's service. Mr. H. Savage becomes joint works manager with Mr. R. J. Hatton. Mr. F. Harris has gone to Buenos Aires to start a contract department for Henley's in that city, and Mr. O. C. Hatton, who was an engineer at the North Woolwich Works some years ago, is shortly taking charge of the company's interests in Brazil.

MR. W. W. BLUNT, who has retired from the position of director of the Metropolitan-Vickers Electrical Company, Limited, to take up an active partnership in an engineering business with his brother in the United States, has been entertained at dinner by his colleagues from Trafford Park and the district offices of the company. Captain R. S. Hilton, managing director of the company, who was in the chair, said it was a source of gratification to know that Mr. Blunt retained a connection with the old company and would represent it in an important position. Mr. Blunt had seen 23 years with the company, the history of the old British Westinghouse Company being the history of Mr. Blunt.

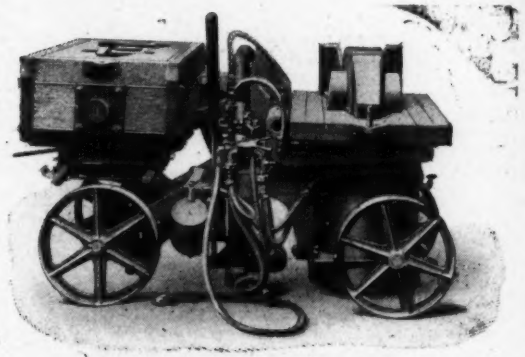
MR. ARTHUR COOPER has retired from the position of managing director of the North Eastern Steel Company, Limited, of Middlesbrough, with which company he has been associated since 1881. Mr. Cooper was born in 1849, and was educated privately. When sixteen years of age he was apprenticed to the late Matthew Kirtley at the Midland Railway Locomotive Works at Derby, and subsequently took a position as assistant in the engineering department of John Brown & Company's works at Sheffield, being transferred three years later to the Bessemer-steel department as manager. That position he resigned in 1874 in order to take up similar duties with the neighbouring Sheffield concern of Brown, Bayley & Dixon (as the style of the firm then was). It was there, in 1879, that Mr. Cooper made the acquaintance of Messrs. Thomas and Gilchrist, who were then carrying on those experiments which eventually brought them fame and fortune as the inventors of the basic process of steelmaking. Mr. Cooper followed these experiments with close attention, with the result that in May, 1880, he was able to present a paper to the Iron and Steel Institute describing "The Manufacture of Basic Steel and Ingot Iron from Phosphoric Pig by the Thomas-Gilchrist Process." The following year saw the formation at Middlesbrough of the North Eastern Steel Company, Limited, for the purpose of working the invention, Mr. Cooper being appointed general manager of the works, of which subsequently he became managing director. Mr. Cooper has been a member of the Iron and Steel Institute since 1874. In 1892 he was awarded the Bessemer Medal, and two years later he was elected a member of the Council. In 1906 he was appointed to the position of Vice-President of the Institute, and occupied the presidential chair from 1912 until 1914.

TABOR

Box and Mould—after being Rammed-in position of being Rolled over.

Portable,
Combination,
Shockless Jarring,
Roll-over
AND
Pattern - Drawing

MOULDING MACHINE.



The Finished Mould—showing Pattern after being drawn.

Capacities and Dimensions upon application to

MACNAB & CO.,

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

Deaths.

THE death has occurred of Mr H. S. Walker, of Messrs. W. G. Walker & Sons, Hawkhill Chemical Works, Ayr.

WE regret to announce the death of Mr. W. Shepherd, a well-known member of the Sheffield Branch of the Institution of British Foundrymen.

THE death took place recently of Mr. J. Braddock, of Oldham, one of the founders of the firm of Messrs. J. & J. Braddock, meter manufacturers. The deceased was 82 years of age.

THE death took place very suddenly on Tuesday afternoon, September 23, of Mr. Frank Foster, a member of the Iron and Steel Institute, who resided at College Road, Whalley Range, Manchester. The deceased gentleman attended a meeting of the Institute in London recently, and contributed to the discussion on the papers, particularly that by Professor Bone, Sir Robert Hadfield, and Mr. A. Hutchinson on fuel economy.

THE death has occurred in Edinburgh of Mr. G. W. Wilkinson, of Hensingham, who was well known in connection with the staple industries of West Cumberland. Mr. Wilkinson was born at Parton, and after being employed for a time on the railway he entered the iron trade and became a partner in the firm of Burnyeat, Dalzell & Company. After the death of Mr. Wm. Dalzell, Mr. Wilkinson started business on his own account as a coke, coal, iron and iron ore merchant, and established an extensive business both in Cumberland and the Furness district.

Applications for Patents.

The names of communicators are printed in Italic type. A new number will be given when the Complete Specification is accepted.

Andersson, A. Apparatus for machining cylinder castings, etc. 24,794. October 10.

Betts, S. Locking-nuts for bolts, machinery, etc. 23,031. September 18.

Blantyre Engineering Company and Ferguson, D. Refuse-tipping plant. 23,215. September 20.

Farrell, D. Pressure-testing tool. 24,881. October 11.

Fletcher, J. E. Manufacture of puddled iron. 22,959. September 18.

Ford, A. P. Nut and bolt-locking devices. 23,110. September 19.

Grundy, H. H. Thermostats. 24,633. October 8.

Heppenstall, N. Casting recessed blocks of concrete. 19,557. August 8.

Hormel, A., and Wagner, C. Drying-apparatus for sheet-metal plates. 22,681. September 15 (United States, September 14, 1918.)

Howard, J. R. Means for packing or loading blooms, billets, bars, etc. 24,837. October 10.

James, E. H. and J. File-cutting machines. 24,545. October 8.

Jarvis, O. Lock-nuts. 22,851. September 17.

Jones, E. H. Repair and reinforcement of iron and steel castings. 24,329. October 6.

Morgan Crucible Company. Electrically-heated melting, etc., furnaces. 24,480. October 7.

Morton, C., and Rathbone, R. L. Twisting wire. 24,613. October 8.

Müller, E. Manufacture of articles from aluminium, etc., or alloy. 24,632. October 8.

Nicholls Company, W. H. Foundry moulding-machines. 20018. (August 14.)

Quasi-Arc Company. Tube joints for superheaters, etc. 19,021. July 31.

Thompson, R. W. Moulds, and process of constructing same for casting metal pipes, tubes, etc. 23,171. September 20.

Winder, W. B. Annealing, hardening, and tempering furnaces. 23,183. September 20.

Zychlinski, P. Lock-nuts. 22,893. September 17.

New Companies.

Midland Sheet Metal Works, Limited. — Capital £1,000 in £1 shares.

Christian Bergh Electric Company, Limited.—Capital £5,000 in £50 shares.

Pearlite Electric Welding Company, Limited. — Capital £10,000 in £1 shares. Registered office: 21, Dale Street, Liverpool.

Dare Valley Motor & Engineering Company, Limited. —Capital £6,000 in £1 shares. Registered office: The Garage, High Street, Aberdare.

Star Electric Engineering & Manufacturing Company, Limited.—Capital £10,000 in £1 shares. Registered office: 134, Victoria Street, Grimsby.

Rowland's Dockyards, Limited.—Capital £10,000 in £1 shares, to take over the business carried on at Bangor, Carnarvon, as W. R. Rowland.

Charles E. Jenkins, Limited.—Capital £5,000 in £1 shares, to carry on the business of forgers. Registered office: 77, Sidney Street, Sheffield, Yorks.

Garrett & Campbell, Limited. — Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office: 88, Chancery Lane, W.C.2.

Ogilvie & Partners, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: Gwydir Chambers, 104, High Holborn, W.C.

Geo. Thomas & Company, Limited.—Capital £12,000 in £1 shares, to carry on the business of engineers. Registered office: Parsonage Lane, Deansgate, Manchester.

J. G. Mortimer, Limited.—Capital £5,000 in £1 shares, to carry on the business of dealers in iron and other metals, etc. Registered office: 1, Cannon Street, Birmingham.

Naval and Patent Light Steel Construction, Limited. —Capital £5,000 in £1 shares (2,500 cumulative preference). Registered office: 15, New Bridge Street, London, E.C.

Alloy Castings, Limited.—Capital £2,000 in £1 shares. First directors: J. Simpson, C. D. Simpson, and C. Simpson. Registered office: Porter Works, Ellin Street, Sheffield.

Newcastle Engineering Company, Limited. — Capital £25,000 in £1 shares, to take over the business carried on at Tyne Dock Entrance, Corstorphine Town, South Shields, as Read & Foggin.

Milree Brothers, Limited.—Capital £5,000 in £1 shares, to carry on the business of iron, steel, metal, and machinery merchants and agents. Registered office: 192, West George Street, Glasgow.

British Horseshoe Nail Company, Limited.—Capital £85,000 in £1 shares, to acquire from J. Murphy and K. A. Roberts the benefit of inventions. First directors: J. Murphy, K. A. Roberts, and H. C. Jagger.

James Hill (Bury), Limited.—Capital £10,000 in £1 shares, to acquire the existing business of general engineers, etc. First directors: Mary J. Hill and J. W. Hill. Registered office: Bury Bridge, Bury, Lancaster.

Rockingham File & Steel Company, Limited.—Capital £2,000 in £1 shares. First directors: F. Potteril-Tilney, W. Charlesworth, and A. Sayles (all permanent). Registered office: 216, Rockingham Street, Sheffield.

Stafford Associated Engineering Company, Limited. —Capital £15,000 in £1 shares, to take over the business carried on by T. Murphy, at 27, Cannon Street, London, E.C., as the Associated Engineering Company.

J. & G. Jagger, Limited.—Capital £5,000 in £1 shares, to take over the business of a cast-steel wire drawer and manufacturer carried on by F. Jagger at Old Wire Mills, Thurgoland, near Sheffield, as J. & G. Jagger.

H. Clarke & Company (Manchester), Limited.—Capital £25,000 in £1 shares, to take over the business of a manufacturer of insulating materials and screws, etc., carried on by H. Clarke, as H. Clarke & Company, at

Telegrams: "Durrans, Pennistone." Telephone: 21, Pennistone.

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

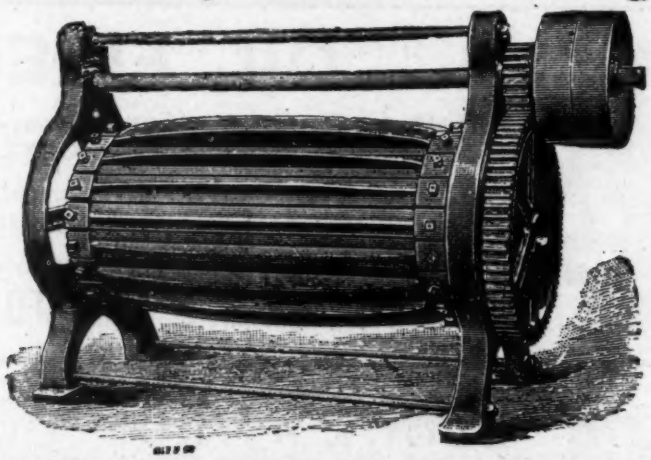
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Eastnor Street, Old Trafford, Manchester. Registered office: 22, Cooper Street, Manchester.

Patent Die Castings Company, Limited.—Capital £100,000 in £1 shares, to take over the business of the Patent Die Castings Syndicate, Limited, incorporated in 1909. First directors: C. L. Simpson and H. Etherington. Registered office: Strode Road, Willesden Green, N.W.

George Black & Sons, Limited.—Capital £20,000 in £1 shares, to take over the business of boiler makers carried on at Tweedmouth, Berwick, as George Black & Sons. First directors:—J. W. Glahome (managing director), L. W. E. Biggings, and W. T. Weir. Registered office:—Margaretville, Main Street, Tweedmouth, Berwick.

Morriston Silica Brick Company, Limited.—Capital £10,000 in £50 shares, to take over the existing business at Clydach Road, Morriston, Glam., and to enter into an agreement with F. W. Gilbertson, F. T. Thomas, W. Gilbertson & Company, Limited, and Richard Thomas & Company, Limited. First directors: F. W. Gilbertson and F. T. Thomas. Secretary: C. Giddings. Registered office: Ynisderw Road, Pontardawe, Glam.

Drayton Iron & Steel Company, Limited.—Capital £850,000 in £1 shares (400,000 preference), to enter into agreements between C. Kidner, on behalf of shareholders of the Islip Iron Company, Limited, of the first part, A. C. J. Wall, on behalf of shareholders of the Bloxham and Whiston Ironstone Company, Limited, of the second part, and the Drayton Iron & Steel Company, of the third part. Registered office: 9, Great St. Helens, E.C.

Wellman Bibby Company, Limited.—Capital £23,000 in £1 shares (3,000 founders), to carry on the business of ironfounders, etc., and to enter into agreements with the Wellman Smith Owen Engineering Corporation, Limited, and J. Bibby. The Wellman Smith Owen Engineering Corporation, Limited, may, while holding £6,000 shares, appoint and remove two directors, and J. Bibby has a similar right whilst holding £7,000 shares. First directors: A. E. Owen (chairman), J. Smith, F. I. Sanderson, J. Bibby, and L. C Harvey.

Allied Steel Makers & Founders, Limited.—Capital £25,000 in £1 shares. Two of the first directors have been nominated by Thwaites Bros., Limited, one each by Lake & Elliot, Limited, and the National Steel Foundry (1914), Limited, and one jointly by the two last-named companies. First directors: T. H. C. Homersham, W. B. Lake, W. Moscrip, A. A. Liardet, and R. J. Dunderdale. Secretary: E. W. Eller. Registered office: West India House, Leadenhall Street, E.C

The British Magnesite Calcining Company, Limited.—(Private company.) Capital £100,000 in £1 shares, to carry on the business of calciners, burners, grinders, millers and pulverisers of magnesite, chrome, bauxite, dolomite or other refractory materials; manufacturers of and dealers in tuyeres, stoppers, nozzles, sleeves, dolomite bricks and other bricks, tiles and pottery, smelters, engineers, etc. The company is to enter into agreements with Adam Mason & Sons, Limited, and Woodall Duckham & Jones, Limited. The first directors are H. Steel, F. W. Cooper, Col. W. C. Wright, C.B., J. R. Horton, T. Cleworth, Sir Wm. J. Jones, K.B.E., G. Scoby-Smith, and A. Dorman. If Steel, Peech & Tozer, Limited, shall not subscribe for or acquire 10,000 shares within thirty days after the incorporation of the company, H. Steel shall cease to be a director, but if that company subscribe for or acquire those shares he may retain office until removed by them or until they cease to hold such shares. There are similar provisions with regard to F. W. Cooper and the Partington Iron & Steel Company, Limited (8,000 shares); to W. C. Wright and Baldwin's, Limited (8,000 shares); to J. R. Horton and the Steetle Lime Company, Limited (8,000 shares); to T. Cleworth and Adam Mason & Sons, Limited (8,000 shares); to Sir Wm. J. Jones and Woodall Duckham & Jones, Limited (8,000 shares); to G. Scoby-Smith, and Bolckow Vaughan & Company (8,000 shares); and to A. Dorman and Dorman, Long & Company (8,000 shares). The directors may from time to time resolve that any other company shall be eligible as a "directing company," subject to holding 8,000 shares. The secretary is R. C. Rann, and the registered office at 14, Great George Street, S.W.1.

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MONTHLY PRICE LIST.

The undermentioned prices unless otherwise specified, are those obtaining at the commencement of the current month.

Pig-Iron.

	Home; £ s. d.
Hematite—	
East Coast Mixed Nos.	10 0 0
East Coast No. 1	10 2 6
West Coast Mixed Nos.	10 4 6
Scottish Mixed Nos.	10 10 0
Welsh Mixed Nos	10 15 0
Cleveland—	
No. 1	8 4 0
No. 3 foundry G.M.B.	8 0 0
No. 4 foundry	8 0 0
No. 4 forge	8 0 0
Basic	8 5 0
Derbyshire, Leices., and Notts—	
No. 4 forge	8 15 0
No. 3 foundry	9 0 0
No. 2 foundry	9 2 0
No. 1 foundry	9 4 0
Basic	9 2 6
Northamptonshire—	
No. 4 forge	8 7 6
No. 4 foundry	8 9 0
No. 3 foundry	8 10 0
No. 2 foundry	8 11 6
No. 1 foundry	8 13 6
Basic	8 17 6
South Staffordshire, Shropshire and Worcestershire—	
Part-mine forge	9 7 6
Part-mine foundry	9 10 0
Common Staffs.	8 7 6
All-mine forge	9 7 6
All-mine foundry	9 12 6
Warm-air forge	11 0 0
Warm-air foundry	11 10 0
Cold blast	14 0 0
Basic	9 2 6
Scottish—	
Foundry	9 15 0

NOTE.—The above prices are those fixed by the makers as a minimum for early delivery. In consequence of works being booked to capacity, makers are not committing themselves for later delivery.

Delivered in Manchester—	
*Derbyshire, No. 3	9 7 6
*Cleveland, No. 3	8 15 0
*Scottish, No. 3	10 12 6

* Merchant prices.

Delivered in Sheffield—	
East Coast hematite	10 8 6
Derbyshire basic	8 17 6
Lincolnshire basic	8 17 6
Do. No. 3 foundry	8 17 6
Do. forge	8 12 6

High-Speed Tool Steel.

	s. d.
Finished bars, 14 per cent. Tungsten	2 11
Finished bars, 18 per cent. Tungsten	3 6
Per lb. delivered buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. per lb.
Rounds and squares under ½ in. to ¼ in.	3d. ,,
Flats under 1 in. by ¼ in. to ½ in. by ¼ in., and all sizes over four times 3 in width and over thickness	3d. ,,
Bevels of approved sizes and sections	6d. ,,
If in Coils	3d. ,,
Packing	4s. per cwt
Bars cut to length	10% extra
Scrap from High-Speed Tool Steel—	
Scrap pieces, 5d.	
Turnings and Swarf, 3d.	
Per lb. net, d/d steel-makers' works.	

Ferro-Alloys.

Ferro-Titanium—23/25 % Ti. carbonless, 1/6.
Ferro-Tungsten.—75/80%, 2/11.
Ferro-Molybdenum.—70/80%, Mo., 9/-.
Ferro-Vanadium.—35/40%, Va., 30/-.
Metallic-Manganese.—98/99%, carbonless, 3/9. (All per lb.).
Ferro-Phosphorus.—20/25%, P. £14 10 0
Ferro-Chrome.—4/6%, car., £42 0 0.
Ferro-Chrome.—6/8%, car., £41 0 0.
Ferro-Chrome.—8/10%, car., £40 0 0.
Ferro-Chrome—Specially refined, basis 60% chr., max. 2% car., £105 0 0.
Ferro-Silicon.—45/50% Si., £19 10 0 d/d. at Sheffield Steelworks.
Ferro-Manganese.—80%, £23 loose, £24 0 0 packed. Export £23, according to destination. (All per ton.).

Copper.

	£ s. d.	£ s. d.
Standard cash	98 5 0	98 10 0
Three months	99 0 0	99 5 0
Electrolytic	114 0 0	118 0 0
Tough	109 0 0	110 0 0
Best selected	110 0 0	111 0 0
Sheets	149 0 0	—
India	148 0 0	149 0 0
American electrolytic spot	117 0 0	118 0 0
Do. Nov.-Dec	117 0 0	117 10 0
Official average price cash, Sept.	100 17 4½	
Do. Three months, Sept.	101 7 10½	
Do. Settlement, Sept.	100 15 8½	
Do. Electro, Sept.	115 5 10½	
Do. B.S., Sept.	109 5 6½	
Average spot price, copper, Sept.	100 15 8¼	
Do. Electro, Sept.	109 16 4½	

Tin.

	£ s. d.	£ s. d.
Cash	273 10 0	273 15 0
Three months	274 10 0	274 15 0
English	271 0 0	272 0 0
Bars	273 0 0	274 0 0
Refined	—	—
Straits	273 15 0	—
Australian		273 10 0
Eastern		287 10 0
Banca		273 10 0
Official average price, cash, Sept.	280 3 11½	
Do. Three months, Sept.	274 15 1½	
Do. Settlement, Sept.	280 4 6½	
Average spot price, Sept.	280 1 9½	

Spelter.

	£ s. d.	£ s. d.
Ordinary	45 0 0	—
Remelted	42 0 0	43 0 0
Hard	32 0 0	33 0 0
Electro 99.9	—	—
English	48 10 0	—
India	44 0 0	45 0 0
Zinc dust	65 0 0	70 0 0
Do. English	—	—
Zinc ashes, per cent. 70%	—	13 0 0
Official average price, Sept.	41 8 4½	
Average spot price, Sept.	41 19 9½	

Lead.

Soft foreign (net)	29 17 6
English	31 5 0
Official average price, Sept.	25 12 6½
Average spot price, Sept.	25 6 7

Antimony.

English regulus	47 10 0
Chinese	46 0 0 to 47 0 0
Crude	36 0 0
Ore	Nominal.

Aluminium.

Virgin Metal 98/99— per ton.	150 0 0

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II.	—
III., IV., or V.	—
IV. or VII	—
VIII.	—
XI.	—
Cast Strips and Ingots	—
CASTINGS.	Per lb.
I. or II.	—
III., IV. or V.	—
IV. or VII.	—
VIII.	—
XI.	—
No. VII., Chill. Cast, Solid	—
,, Cored Bars	—
Delivery 2 Cwt. free to any town.	
10 per cent. Phosphor Copper price of best selected copper.	£50 above
15 per cent. Phosphor Copper price B.S.	£70 above
Phosphor Tin (5 per cent.) price of English Ingots.	£30 above

Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM.

*Chromium (Metallic).

98/99— purity, per lb. 6/6	—

*Nickel.

In cubes, 98/99— purity per ton	£205 0 0

Nickel Silver.

	per lb.
Ingots for raising	1/6 - 1/11
Ingots for Spoons and Forks	1/6 - 1/11
,, rolled to spoon size	1/8 - 2/1

*Tungsten Metal Powder.

	per lb.
96/98— purity	3/4

*Molybdenum Metal.

96/98— purity, per lb	—

*Cobalt Metal.

	£ s. d.
97— purity, per lb.	0 10 6

Quicksilver.

75 lb. bottle	16 17 6

* Net, delivered Sheffield Works.

Scrap Iron and Steel.

	Cleveland. s. d.	s. d.
Steel scrap, heavy melting	—	—
Iron scrap cast (cupola metal)	—	—
(London f.o.b.).		
Heavy steel	125 0	
Light ,,	80 0	
Heavy cast	120 0	

Steel Scrap.

Without Analysis—	Per ton £ s. d.
Heavy steel melting scrap	6 15 0
Steel planings, turnings and borings	4 15 0
Steel planings, turnings and borings mixed with wrought-iron or other material	4 0 0
Other classes of steel scrap, whether or not mixed	6 5 0
F.o.r. or in barge at nearest siding or wharf.	
With Analysis—	
Heavy steel melting scrap not over 0.04 per cent. p. and s.	7 10 0
Heavy steel melting scrap not over 0.05 per cent. p. and s.	7 5 0

Wrought-Iron Scrap.

	£ s. d.
(1) (a) W.I. plates and sections, not less than ¾ in. thick, reasonably clear of rivets, flanged ends, etc., suitable for shearing: cable scrap and chain scrap not less than ¾ in. dia.	7 17 6
(b) Heavy W.I. scrap not less than ¾ in. thick including horseshoes, rivets and bolts, and scrap therefrom	7 17 6
(c) W.I. scrap under ¾ in. thick, and all W.I. scrap not included in classes 1, 2 and 3	7 17 6
(2) Mixed W.I. scrap	6 7 6
(3) Wrought-iron planings, turnings and borings mixed with steel or other materials	4 2 6
(4) W.I. planings, turnings and borings	4 17 6

Cast-Iron Scrap.

	£ s. d.
Heavy ord., broken, between 1½ cwt. and 10 cwt. each	6 15 0
Heavy machinery, broken between 1½ cwt. and 10 cwt. each	7 0 0
Cold blast, broken, between 1½ cwt., and 10 cwt.	8 15 0
Ingot mould, unbroken	8 0 0
Do. broken, between 5 cwt. and 2 tons each	8 5 0
Do. between 1½ cwt. and 5 cwt. each	8 10 0
Railway chairs, whole or broken for remelting	7 0 0
Heavy lumps, not exceeding 2 tons each	6 12 6
Light	6 5 0
Burnt, broken ready for cupola	5 10 0
Burnt fire bars	6 0 0
Turnings and borings, for iron and steel makers	5 5 0

Old Metal.

London—	£ s. d.
Copper (clean)	90 0 0
Brass (clean)	53 0 0
Lead (less usual draft)	25 0 0
Tea lead	23 10 0
Zinc	28 0 0
New aluminium cuttings	100 0 0
Brazier copper	76 0 0
Gunmetal	76 0 0
Hollow pewter	200 0 0
Shaped black pewter	140 0 0

(Above all d.d merchant's yard).

Metallurgical Coke.

Durham and Northumberland—	£ s. d.
Blast furnace	2 8 0
Foundry	2 13 6
Lancs., Staffs., Yorks, Notts., Derbyshire, Lincolnshire and Midland Counties—	
Blast furnace	2 10 6
Foundry ,,	3 6 0

F.o.t. at ovens.

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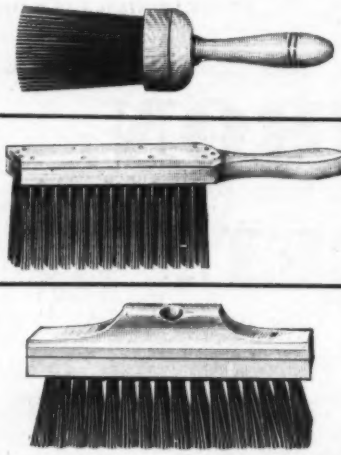
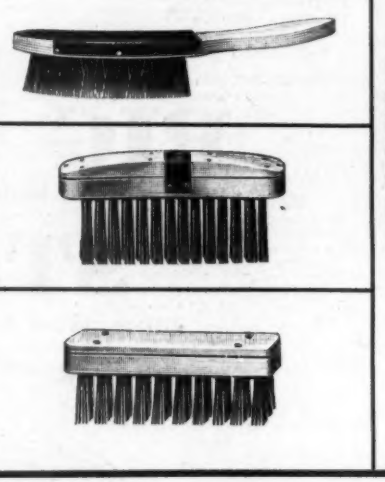

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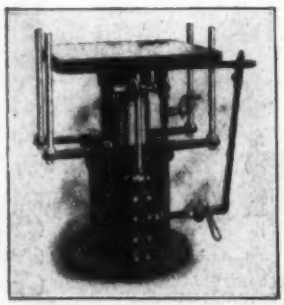

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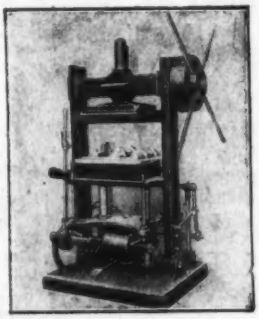

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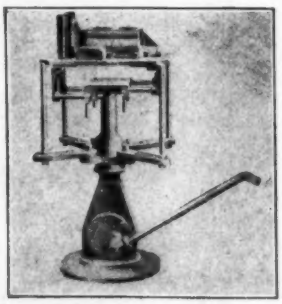

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FOREMAN COREMAKER desires situation. Age 40. Good references. Has the ability to initiate, control and direct large iron foundry (non-society) preferred.—Coremaker, Box 330, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2

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EXPERIENCED man required to organise, equip, and control medium-sized Foundry in Eastern Counties making all classes of Castings for small Internal Combustion Engines. Special experience in Cylinder Casting and Moulding Machines. Applicants must have sound experience in the latest Foundry Methods with up-to-date firms, and also a technical training in the mixing of metals. Only men of proved ability will be considered.—Apply, stating age, experience, and salary required, to Box No. 342, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

THE DERWENT FOUNDRY COMPANY, LIMITED, of DERBY, require a thoroughly capable man to take charge of their pattern department. The work comprises patterns in wood, lead, plaster, iron and gunmetal, all finished to a very high degree of accuracy; also the supervision of the mounting of patterns for machine moulding. The best man possible is wanted, position is permanent for right man, and he will be paid highly for success.—Apply by letter.

UNDER-FOREMAN required for Grey Iron and Brass Foundry in Leicestershire. Average output of grey iron per week, 25 tons; brass and bronze, 1½ tons. Must be a thoroughly practical moulder, with a good technical education. F.M.B. man preferred. Permanent progressive position offered to a really good man.—Apply Box No. 346, FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

AS WORKS MANAGER for Steel Foundry engaged on repetition work, an Engineer, with good foundry experience, who has proved his capacity for management. An excellent opening for an energetic man conversant with modern methods.—Applicants should send full particulars of their qualifications, with age and salary required, to THE NATIONAL STEEL FOUNDRY (1914), Limited, Kirkland Works, Leven, Fife.

PATTERN FITTER wanted. One accustomed to first-class plate pattern work. Give experience, age, and wages required.—Box 336, Offices of THE FOUNDRY TRADE JOURNAL Bessemer House, Adelphi, Strand, London, W.C.2.

WANTED, CAPABLE MOULDER, thoroughly experienced in the making of plate patterns. Give full particulars of past employment, state age, and wages required.—Box 334, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

WANTED, FOUNDRY FOREMAN to take charge of foundry (about 100 hands) engaged entirely on repetition work. Only those expert in repetition work and the use of moulding machines need apply. State age, experience, and wages required.—Box 332, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

REQUIRED, a Capable Engineer, with general foundry experience, to develop the commercial side of a modern iron foundry. Apply, stating experience and salary required, to Box No. 336, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

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PATTERN-MAKERS.—Wanted, two or three first-class pattern-makers, accustomed to small work. —Apply, Box No. 278, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, Adelphi, Strand, London, W.C.2.

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WANTED, CUPOLA, to melt 10 to 12 tons per hour, complete with hoist and charging platform; also suitable blower. Full particulars to Box 340, Offices of THE FOUNDRY TRADE JOURNAL, Adelphi, London, W.C.2.

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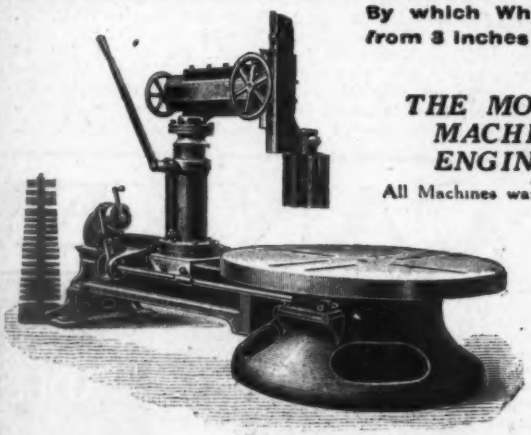

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